Engineering Library

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VOL. CXXXIX.—No. 3606] LONDON: FRIDAY EVENING FEBRUARY 6, 1925 [PRICE { WITH SUPPLEMENT } ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The Director - General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for:
GIRDER BRIDGE WORK.
Tenders due on the 20th February, 1925.
Tender forms obtainable from above. 8306

Air Ministry Requires SERVICES of WATER SUPERINTENDENT for period of 2 years in Iraq (Mesopotamia). Inclusive salary £450 per annum.
Applicants should be between 30-35 years of age, have been trained as mechanical engineers with work shop experience and have subsequent experience in the construction and maintenance of Waterworks Plant. They should have a thorough knowledge of water filtration and treatment systems and pumping plants, and be capable of supervising the laying of mains, construction of reservoirs, and erection of storage tanks. Ex-Service men preferred.
Apply at once by letter, stating age, qualifications and experience, to the SECRETARY (S.2), Air Ministry, Adastral House, Kingsway, W.C. 8312

Civil Engineers Required by the GOVERNMENT of CEYLON for APPOINTMENT as IRRIGATION ENGINEERS for three years in the first instance. Salary £500, rising to £900 a year by annual increments of £40 (£600 on attaining 30 years of age). Free passage provided. Candidates, preferably unmarried, age 26 to 31, must have had war service and passed the examinations to qualify for Associate Membership of the Institution of Civil Engineers or hold equivalent professional qualifications, and have had at least three years' practical experience on waterworks drainage, or harbour and dock works.—Apply at once by letter, stating whether married or single, age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting at head of application M/12,342. 8304

District Engineer Required by the GOVERNMENT of PALESTINE, for the RAILWAY DEPARTMENT, for three years' service, with prospect of permanency. Salary £E550-25-750 a year. Expatriation allowance of £E50 a year plus a variable cost-of-living allowance at present fixed at £E37, plus 5 per cent. of the minimum salary. Free first-class passages. Candidates, aged 30 to 35, preferably single, must have had not less than 5 years' experience on British railways on maintenance and construction work. Should be an A.M.I.C.E.—Apply at once in writing, stating age, whether married or single, and giving brief details of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting at the top of application M/13,986. 8286

Section Engineers (6) REQUIRED for the Construction Branch of the FEDERATED MALAY STATES RAILWAYS, for three years' service, with possible extension. Salary 400 dollars a month, rising to 475 dollars a month by annual increments of 25 dollars a month plus a temporary non-pensionable allowance of 10 per cent., which is liable to cancellation or revision, plus a commuted field allowance of 50 dollars a month. The exchange value of the dollar in sterling is at present fixed by the Government at 2s. 4d., but its purchasing power in Malaya is at present considerably less than that of 2s. 4d. in the United Kingdom. Free passage provided. On expiration of agreement a bonus of four and a half months' salary may be allowed provided the work and conduct of the person engaged has been in every way satisfactory. Candidates, age 25 to 38 and unmarried, must be fully qualified railway engineers who have received good training and experience on recognised European, American or Colonial railways. Members or associate members of the Institution of Civil Engineers preferred.—Apply at once by letter, stating age, and particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting at top of application M/13,364. 8253

INDIAN SERVICE OF ENGINEERS.

The Secretary of State for India in Council will in 1925 APPOINT a ASSISTANT EXECUTIVE ENGINEERS for this Service if so many suitable candidates present themselves.
Every candidate must be a European British subject and must be not less than 21 years and not more than 24 years of age on 1st August, 1925.
They must either (1) have obtained one of certain recognised University degrees or other distinctions in Engineering, or (2) have passed Sections A and B of the Associate Membership Examination of the Institution of Civil Engineers or been exempted by the Institution from such examination, or (3) produce the required evidence that they are otherwise eligible under the Regulations. They must in addition have had at least one full year's practical experience of Civil Engineering under a qualified Civil Engineer at the time when they appear before the Selection Committee.
Applications from candidates must reach the India Office not later than 1st April. Printed forms, together with information regarding the conditions of appointment, may now be obtained from the SECRETARY, Public Works Department, India Office, Whitehall, London, S.W. 1. 8240

County of London.
SCAVENGING, &c., OF THAMES EMBANKMENTS AND BRIDGES.
The London County Council invites TENDERS for the SCAVENGING, &c., of the THAMES EMBANKMENTS and BRIDGES for a contract for twelve months commencing 1st April, 1925.
Persons desiring to submit Tenders may obtain the form of Tender, &c., on application to the Chief Engineer at the Old County Hall, Spring-gardens, S.W. 1, upon payment of the sum of £3 by cheque or draft to the order of the London County Council. This amount will be returnable only if a bona fide Tender is sent in and not subsequently withdrawn. Full particulars of the work may be obtained on personal application, and the contract documents may be inspected before payment of the fee.
No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 23rd February, 1925, will be considered.
The Council does not bind itself to accept the lowest or any Tender.
JAMES BIRD,
8265 Clerk of the London County Council.

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

Simla Water Supply, 4200ft. Head Pumping Plant (With a Two-Page Drawing).

The British Steam Railway Locomotive from 1825 to 1924—No. 6.

Influence of Pulsations on Combustion.

Ship's Motor Lifeboat with Wireless Equipment.

7150 B.H.P. Gas Engine.

Main Line Electrification in Scandinavia.

The Philosophy of Cutting.

French Locomotive Performances.

PUBLIC NOTICES

County Borough of Salford.
ELECTRICITY DEPARTMENT.
PLANT FOR IMMEDIATE DISPOSAL.
(a) 1 TURBO-ALTERNATOR of a capacity of 5000 K.W., with 160 lb. steam pressure at the stop valve, 1500 r.p.m., 6600 volts, 50 periods, complete with surface condenser of 11,500 sq. ft. cooling surface, motor-driven circulating pump, also steam-driven air pump and steam air ejector.
(b) 8 LANCASHIRE BOILERS, 8ft. diameter by 30ft. long, fitted with mechanical stokers and superheaters, all in working order, and guaranteed for a pressure of 165 lb. per square inch.
(c) 2 STACKS of GREEN'S CAST IRON ECONOMISERS, each with 400 tubes, complete for a pressure of 200 lb. per square inch.
The whole of the above plant is in daily use and can be seen in commission by arrangement.
Full particulars and forms of Tender may be obtained on application to the Borough Electrical Engineer, Electricity Works, Frederick-road, Pendleton.
Tenders should be received not later than Twelve Noon on Monday, the 23rd instant.
8257 L. C. EVANS, Town Clerk.

PUBLIC HEALTH ACT, 1875.
Urban District of Stevenage,
HERTFORDSHIRE.
The Urban District Council of Stevenage, acting as the Sanitary Authority for the said district, are prepared to receive TENDERS for the RECONSTRUCTION of the STEVENAGE OUTFALL WORKS.
Particulars and specification may be obtained at the offices of the Consulting Engineers, Messrs. Howard Humphreys and Sons, 28, Victoria-street, Westminster, or at the office of the Clerk to the Council, Stevenage, on and from Friday, the 6th of February, until Saturday, the 14th of February, between the hours of 10 a.m. and 4 p.m., upon payment of a deposit of Three Guineas, which deposit will be returned upon receipt of a bona fide Tender which is not subsequently withdrawn by the contractor.
The successful tenderer will be required to execute a contract deed, the draft of which may be seen at the offices of the Consulting Engineers when the drawings are inspected.
Tenders must be on the official form, each Tender in a sealed envelope, marked "Tender for Outfall Works." Tenders must be accompanied by the general conditions and specification as issued by the Consulting Engineers.
Each Tender must be signed in the handwriting of the tenderer or his authorised agent.
The Council does not bind itself to accept the lowest or any Tender.
Tenders must reach the undersigned by 9 a.m. on Saturday, the 28th of February, 1925.
Given under my hand the 3rd day of February, 1925.
W. O. TIMES,
Clerk to the Stevenage U.D.C.
Council Offices,
Stevenage, Hertfordshire. 8283

Belfast Harbour.
The BELFAST HARBOUR COMMISSIONERS REQUIRE the SERVICES of a fully qualified MECHANICAL ENGINEER, to fill the POSITION of ASSISTANT MECHANICAL SUPERINTENDENT, at a salary after the rate of £300 per annum.
Applicants must not be more than 40 years of age and must have had experience in the shops of an engineering works, together with a sound technical knowledge.
The candidate appointed to the position will be required to devote his whole time to the service.
Applications, giving full particulars of experience and training, accompanied by not more than three copies of recent testimonials, are to be sent in on or before Wednesday, the 25th February, 1925, addressed to the undersigned and endorsed "Mechanical Engineer."
M. J. WATKINS,
8268 General Manager and Secretary.

PUBLIC NOTICES

Tyne Improvement Commission.
MOTOR FERRY LAUNCH.
The Tyne Improvement Commissioners are prepared to receive TENDERS for the CONSTRUCTION and DELIVERY in the Tyne of a MOTOR BOAT about 52ft. long, 11½ft. beam, speed not less than 7½ knots per hour, for passenger ferry service.
Copies of the form of Tender, conditions of contract, specification and contract drawing may be obtained from this office on payment of a deposit of £2 2s., which will be returned on receipt of a bona fide Tender.
Tenders, in sealed envelopes, endorsed "Tender for Motor Ferry Boat," must be delivered at the undermentioned offices, addressed to the Chairman, Harbour and Ferry Committee, not later than Noon on Thursday, the 26th day of February, 1925.
The Commissioners do not bind themselves to accept the lowest or any Tender.
By Order,
ALBERT BLACKLOCK,
Secretary.
Tyne Improvement Commission Offices,
Bewick-street, Newcastle upon-Tyne,
5th February, 1925. 8306

Sudan Government Railways REQUIRE the SERVICES of a DISTRICT ENGINEER. Age 26 to 32, preferably single. Starting rate of pay £E480 to £E540, according to age and qualifications. Candidates should possess A.M.I.C.E. degree or equivalent. Should have practical experience in railway construction and maintenance on British railway. Progressive and pensionable post if retained. Free first-class passage. Strict medical examination.—Apply by letter, with full particulars, to the CONTROLLER, Sudan Government, London Office, Wellington House, Buckingham-gate, S.W. 1, marking the envelope "District Engineer." 8260

Egyptian State Railways, Telegraphs and Telephones.
"THE EGYPTIAN RAILWAY ADVERTISER."
A weekly publication in Arabic, English and French.
Subscription: 50 Egyptian Piastres (about 10 shillings) yearly.
An organ of the Egyptian State Railways, Telegraphs and Telephones, containing information of interest to Contractors and Suppliers of Materials and Stores used by the Administration.
For particulars apply to PUBLICITY SECTION, Egyptian State Railways, Cairo (Egypt). 8085

SITUATIONS OPEN

WANTED, an Experienced ENGINEER, for a Chemical Works near London.—Address, stating age, training, and salary required, sending copies of testimonials, 8286, The Engineer Office. 8238 A

WANTED by a Leading Boiler Insurance Company, ADDITIONAL BOILER INSPECTORS. Applicants must be practical Engineers, with a technical training, holding a first-class or extra first-class Board of Trade Certificate, capable of making accurately dimensioned Sketches of all classes of Steam Boilers, and writing clear reports on condition. Commencing salary, £300 per annum.—Address, 8273, The Engineer Office. 8273 A

SITUATIONS OPEN (continued)

WANTED, ASSISTANT MAINTENANCE ENGINEER; under 28 years of age; University and Shop Experience essential.—Apply by letter, stating qualifications and experience, Mark envelope "G.E." top left-hand corner.—E. S. and A. ROBINSON, Ltd., Bristol. 8287 A

WANTED, WORKS MANAGER for India. Actual experience manufacture Switches, Crossings necessary. Must be young, energetic. Fullest details.—Address, 8258, The Engineer Office. 8258 A

ASSISTANT CIVIL ENGINEER REQUIRED IMMEDIATELY for Sudan, aged 23 to 27, unmarried must have first-rate technical qualifications and have had practical experience of levelling, making contour plans, designing works, &c. Irrigation experience desirable. Commencing salary about £500.—Write full particulars and copies testimonials to "C. T.," c/o J. W. Vickers and Co., Ltd., 5, Nicholas-lane, E.C. 4. 8266 A

CHAIN MANUFACTURE.—REQUIRED, by a large Lifting Machinery Manufactory in the Midlands, the SERVICES of a well-educated, thoroughly practical ENGINEER, to Take Charge of their Crane and Block Chain Plant, which is equipped with the most modern types of Electrical and Mechanical Machines for the production of highest grade Steel Chain. All applications will be treated in strictest confidence, but only those who have had previous experience on such work should apply. A sound permanency, with progressive salary, to the right man.—Address in first instance, P205, The Engineer Office. P205 A

CIVIL ENGINEERING ASSISTANT WANTED; thoroughly experienced in the complete design of Stone and Steel and Concrete Railway and Road Bridges.
Address applications, stating experience and salary required, with copies of not more than three recent testimonials, P225, The Engineer Office. P225 A

ENGINEER-IN-CHARGE of DEPOT REQUIRED, for Running and Maintenance of Heavy Road Wagons, both steam and petrol.—Address, giving fullest particulars of qualifications and experience, 8243, The Engineer Office. 8243 A

ENGINEER REQD., with Good Exp. Heavy Oil Engines and some commercial training, for Singapore. Aged 25/30, single, well educated. £500 p.a.
ENGINEER REQD., with good practical and technical exp., for Oilfields, S. American. Single, 25/30. £400/500 p.a., qtrs., &c.
YOUNG MINE SURVEYOR REQD., S. America. School of Mines training and practical exp. ess. Aged 23/28. £300 p.a., qtrs., &c.
CEMENT ENGINEER, with good exp. Cement Manufacture, REQD., India. Rs. 600/700 p.m. Aged 30/35.—Apply, LAURIE'S, Employment Specialists, 28, Basinghall-st., E.C. 2. No preliminary fee. 8311 A

ESTIMATOR REQUIRED, Capable of Making Estimates from project drawings for Mechanical Handling Plants for coal and other materials. Only men with good experience and proved abilities need apply. State age, experience, and salary required.—Address, 8165, The Engineer Office. 8165 A

FIRST-CLASS ESTIMATING CLERK REQUIRED, familiar with Wrought Iron Tube Trade. State age, qualifications, and salary required.—Address, 8309, The Engineer Office. 8309 A

GENTLEMAN REQUIRED for London Office of important Steel Tube Company, as MANAGER; must be well known to buyers and purchasing agents of engineers, railway companies, and export houses.—Address, giving full particulars of experience, salary required, &c., 8275, The Engineer Office. 8275 A

MANAGER.—GENERAL MANAGER (or MANAGING DIRECTOR) WANTED for Engineering Works; must have special experience in Foundry Work and Steel Construction generally, including Gas Plant; able to revise estimates and carry out commercial negotiations. Liberal salary to first-class man.—Applications, which will be treated in strict confidence, to be made in first instance to "ENGINEER," c.o. Fairbairn, Wingfield and Wykes, 67, Watling-street, E.C. 4. P204 A

NORTH SPAIN.—WANTED, a Thoroughly Qualified Spanish-speaking English ENGINEER. Permanent. Good salary.—Address, 8293, The Engineer Office. 8293 A

MECHANICAL ENGINEER REQUIRED for Position of responsibility in the Tropics, to Supervise the Erection of New Plant, together with the running and maintenance of existing plant. Experience in the management of Large Oil Mills or Sugar Factories and a knowledge of French desirable. Only applicants having first-class qualifications and of proved ability will be considered. Applications should state fully experience, age (30-35), and salary expected.—Address, 8264, The Engineer Office. 8264 A

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SITUATIONS OPEN (continued)

REQUIRED for British Engineering Works in India, an ENGINEER as SENIOR ASSISTANT to the Management, experienced in Bridge and Steel Constructional Work; applicants must have thorough Workshops, Drawing-office, Designing and Estimating Experience. None but experienced men need apply. Age, 30 to 38.—Write, stating age and giving full particulars of previous experience, to "Z.L. 777," c.o. Deacon's, Leadenhall-street, London, E.C. 3. 8291 A

SALES ENGINEER REQUIRED. Well Versed in Fan Engineering generally and especially in respect of Power Boiler-house and Marine Practice, Combustion, Fuels, &c. Good connection among power-house engineers a recommendation. State salary required and experience.—Address, P228, The Engineer Office. P228 A

STRUCTURAL STEELWORK.—First-class DESIGNER and ESTIMATOR REQUIRED by well-known Manchester Firm; thoroughly conversant with the Design of Steelwork for Factories, Warehouses and Office Buildings. Only men acting in similar capacity will be considered.—Address, stating age, details of experience and salary required, with references to recent employers, 8279, The Engineer Office. 8279 A

WATER TURBINE ENGINEER REQUIRED in Hydro-electric Department of large Engineering Firm in London. Must be experienced in compilation of tenders and drawings. Good references essential.—Address, stating age and salary required, 8313, The Engineer Office. 8313 A

WANTED, CHIEF DRAUGHTSMAN. Exceptional prospects for really capable man with thorough technical knowledge of Refrigeration and Dairy Plants. State age, experience, qualifications, and salary.—Address, P223, The Engineer Office. P223 A

WANTED, DESIGNER-DRAUGHTSMAN for Refrigerating Machinery; small and medium-size Compressors and Lay-outs. Those with practical experience will be given preference. State age, experience and salary expected.—Address, 8277, The Engineer Office. 8277 A

A DRAUGHTSMAN, Having a Good Experience in Constructional Steel Work, is REQUIRED by a firm in East London. Send full particulars of experience and age and salary required.—Address, P215, The Engineer Office. P215 A

ASSISTANT CHIEF DRAUGHTSMAN REQUIRED in Lancashire area, thoroughly accustomed to Steel Roofs and Buildings. Salary about £400 per annum. Give full particulars with application.—Address, 8252, The Engineer Office. 8252 A

CARRIAGE and WAGON DRAUGHTSMAN REQUIRED; must have had first-class experience in Design and Modern Carriage and Wagon Practice.—Applications, giving particulars of age, technical education, experience and salary required, should be made, not later than February 14th, to the CHIEF MECHANICAL ENGINEER, Waterloo Station, Southern Railway. 8285 A

CONSTRUCTIONAL STEEL WORK DRAUGHTSMAN for Westminster office, to prepare details for putting work in shop. Must be speedy and accurate. State age and salary required.—Address, 8253, The Engineer Office. 8253 A

DESIGNING DRAUGHTSMAN REQUIRED in connection with Coal and Mechanical Handling Plants. Only men with complete knowledge and first-class experience need apply. State age, experience, and salary required.—Address, 8166, The Engineer Office. 8166 A

DRAUGHTSMEN.—BEFORE NEGOTIATING with Government Departments in connection with any post, PLEASE COMMUNICATE with the GENERAL SECRETARY, Association of Engineering and Shipbuilding Draughtsmen, 96, St. George's-square, London, S.W. 1. 7871 A

DRAUGHTSMAN, Experienced in Hydraulic and Electrical Work, for firm at Southall, Middlesex. State age, experience and salary expected.—Address 8190, The Engineer Office. 8190 A

DRAUGHTSMAN.—First-class MECHANICAL DRAUGHTSMAN WANTED by firm in N.W. London. Only men with sound technical training and thorough practical experience will be considered. Good position for right man.—Address, stating age, experience, and salary required, 8164, The Engineer Office. 8164 A

DRAUGHTSMAN.—REQUIRED, JUNIOR DRAUGHTSMAN, accustomed to preparing drawings of Low-pressure Hot Water Heating Installations for small houses. State experience and salary.—Address, 8246, The Engineer Office. 8246 A

DRAUGHTSMAN, Thoroughly Experienced in Machinery Erection Drawings for Bakery Equipment; must also be able to control men. First-class experience necessary. State salary, age, experience.—Address, 8259, The Engineer Office. 8259 A

EXPERIENCED DRAUGHTSMAN REQUIRED for Railway Work on the Continent. Experience in design of Railway Structures, Permanent Way, &c., essential.—Address, stating salary required and giving full particulars of education, training and experience, 8295, The Engineer Office. 8295 A

EXPERIENCED DRAUGHTSMAN REQUIRED, having knowledge of Hydraulic Turbines and Governors. Must be able to execute workshop drawings under guidance of designer.—Address, stating age and salary required, 8314, The Engineer Office. 8314 A

EXPERIENCED DRAUGHTSMEN WANTED for Steam Turbines, Internal Combustion Engines, and Power Station Lay-outs.—Write, stating age, training, experience, and salary expected, to CHIEF DRAUGHTSMAN, English Electric Company, Ltd., Rugby. 8310 A

EXPERIENCED TRACER REQUIRED.—Please state age, salary required, and forward sample of work to Box 855, T. B. Browne's Advertising Offices, 163, Queen Victoria-street, E.C. 4. 8248 A

LOCOMOTIVE DRAUGHTSMAN REQUIRED; must have had first-class experience in Design and Modern Locomotive Practice.—Applications, giving particulars of age, technical education, experience and salary required, should be made, not later than February 14th, to the CHIEF MECHANICAL ENGINEER, Waterloo Station, Southern Railway. 8284 A

REQUIRED, Experienced DESIGNER for Transformer Department of Large Electrical Firm. Applicants should state experience and salary required.—Address, 8244, The Engineer Office. 8244 A

SEVERAL DRAUGHTSMEN, with Mechanical and Electrical Experience, REQUIRED for Aircraft Work.—Apply, giving full particulars of experience and salary required, to BOULTON and PAUL, Ltd., Riverside Works, Norwich. 8255 A

STRUCTURAL DRAUGHTSMAN WANTED in London district, having a knowledge of preparing shop details for Steel-frame Buildings. State age, previous experience, and salary expected.—Address, 8305, The Engineer Office. 8305 A

SUDAN GOVERNMENT RAILWAYS REQUIRE the SERVICES of CIVIL ENGINEERING or ARCHITECTURAL DRAUGHTSMAN. Should have had experience in Permanent Way Lay-outs and/or Architectural experience. Age 26 to 32, preferably single. Starting rate of pay £E360 per annum, progressive and pensionable post if retained.—Apply by letter, with full particulars of experience, &c., to the CONTROLLER, Sudan Government, London Office, Wellington House, Buckingham-gate, S.W. 1, marking the envelope "Draughtsman." 8307 A

JUST OUT. PRICE 12/6 net.

A Handbook on

BALL AND ROLLER BEARINGS.

By A. W. MACAULAY, A.M.I.Mech. E., with an Appendix on the Gyroscopic action which takes place in Ball and Roller Bearings by PROFESSOR GOODMAN.

This is the first complete book on Ball and Roller Bearings issued in this country. It is a simple exposition of present-day theories and practice. It contains descriptions of the various types now in use, and full instructions for the selection, fitting and maintenance of ball and roller bearings for a very large number of industrial purposes. It will prove of considerable use to designers of general engineering works, automobile engineers, makers of machine tools, rolling stock, etc.

"The illustrations are of exceptional fullness. Like the text, they have been made and chosen with the object of enabling manufacturers to improve their productions, draughtsmen to design their machines suitable for such bearings, machinists to fit them skilfully, and users to use and maintain them intelligently."—*Times Trade and Engineering Supplement.*

SIR ISAAC PITMAN & SONS, LTD., PARKER STREET, KINGSWAY, W.C. 2.

SITUATIONS OPEN (continued)

TOOL DRAUGHTSMAN REQUIRED for Electrical Instrument Works in Essex; must have had experience in Designing Tools and Gauges for small parts; Electrical Knowledge an advantage, but not essential.—Address, stating age, experience, when available, and salary required, 8282, The Engineer Office. 8282 A

FOREMAN REQUIRED in South of England Railway Shop, to Take Charge of Foundry for Casting Railway Chairs.—Address, by letter, giving age, experience, and wages required, 8261, The Engineer Office. 8261 A

FOREMAN WANTED for Structural Steel Works, North-East Coast. A pushing energetic man. Must have a very good knowledge of costs. State age, wages required, and fullest particulars in strict confidence.—Address, 8230, The Engineer Office. 8230 A

FOUNDRY FOREMAN WANTED, to Take Charge of Cast Iron and Brass Foundry in specialised Engineering Works. Must have experience in large castings. Output 50 tons per week. State age, experience, and salary required.—Address, P197, The Engineer Office. P197 A

SITUATIONS WANTED

CIVIL ENGINEER, FAR EAST (Now Near Singapore), WISHES CHANGE POST; experienced in every kind of construction work, good commercial knowledge and organising ability, speaks English, French, Dutch, Malayan, age 30, unmarried.—Address, P214, The Engineer Office. P214 B

ENGINEER, First-class Experience with Leading firms on steam (turbines and reciprocating) and I.C. (gas and oil) engines, colliery machinery, and general engineering. Good organiser and controller, well-up on production methods, has successfully held positions as assistant works manager and foreman, DESIRES POSITION as Works Manager or Assistant, with plenty of scope.—Address, P222, The Engineer Office. P222 B

ENGINEER, Wide Experience, Erection, Maintenance, repairs, dismantling mec., elec., ref. plant, I.C. engines, pumping and general factory plant, at home and abroad, DESIRES SUPERVISION of such work, or will CARRY OUT JOBS on contract or other basis, at home or abroad. First-class references.—Address, P212, The Engineer Office. P212 B

ENGINEER (23½), B.A. (Cantab.), B.Sc. (Lond.), A.M.I.M.E. examination, with two years' works experience, mainly on oil engines, DESIRES POST, home or abroad.—Address, P198, The Engineer Office. P198 B

PRACTICAL ENGINEER (25), Physical Lab. and works routine, knowledge of research, experimental heat treatment, casting, &c., DESIRES CHANGE.—Address, P221, The Engineer Office. P221 B

ENGINEER (32), 16 Years' Design, Inspection, tests, erection, and commercial, OPEN for NEW APPOINTMENT, preferably commercial side, requiring fully trained engineer. First-class references from consulting engineers.—Address, P224, The Engineer Office. P224 B

ENGINEER (34), Workshop, Technical and Commercial training, experienced design, lay-out, erection complete industrial plants, SEEKS POST, D.O., erection, buying, &c.—Address, P151, The Engineer Office. P151 B

ENGINEER (29) DESIRES CHANGE, Engineer or Works Manager. Thoroughly experienced blast-furnace and foundry management, equipment and maintenance, costing, estimating; sound business common sense, practical, technical, good education and address.—Address, P9955, The Engineer Office. P9955 B

EXPERT Experimental and Development ENGINEER DESIRES responsible CHANGE. Sound tech. and practical experience, design, manufacture and testing. Diesel, semi-Diesel, petrol engines. Highest quality only. Competent leader and manager.—Address, P226, The Engineer Office. P226 B

FIRST-CLASS MECHANICAL and ELECTRICAL ENGINEER, with 18 years' practical experience with well-known firms, will SHORTLY be READY to take up a NEW APPOINTMENT. Has held responsible positions on both the technical and commercial sides and holds the degrees of M.Sc., A.M.I.C.E. and M.I.A.E. Interview by appointment in London or elsewhere.—Address, P205, The Engineer Office. P205 B

MECHANICAL ENGINEER DESIRES APPOINTMENT; 18 years' experience in responsible positions on staff of large works and factories at home and abroad. Expert draughtsman.—Address, P216, The Engineer Office. P216 B

MECHANICAL ENGINEER (21), Good Education and appearance, having completed shop practice, SEEKS POSITION where wider experience can be obtained.—K., Box 236, Smiths' Agency, Ltd., 109, Fleet-street, E.C. 4. 8280 B

RESIDENT ENGINEER, or to GET OUT CONTRACT PLANS assisted by draughtsmen. Docks, railways, bridges, tunnels, roads.—Address, P187, The Engineer Office. P187 B

SALES ENGINEER, 5 Years' Experience Representation and management, REQUIRES POSITION with go-ahead firm, not necessarily engineers. Good correspondent with ideas for sales promotion, sound education, age 28.—Address, P200, The Engineer Office. P200 B

SITUATIONS WANTED (continued)

STRUCTURAL ENGINEER, A.M.I. Struct. E., more than 20 years' commercial experience, with first-hand knowledge of works management, draughtsmanship, costs and clerical duties, DESIRES Managerial or other responsible POST.—Address, P159, The Engineer Office. P159 B

TECHNICAL SHORTHAND-TYPIST (Lady) SEEKS POST; experience includes 4 years as secretary to chief engineer (all services), large concern; excellent testimonials.—Address, P210, The Engineer Office. P210 B

YOUNG ENGINEER (26) DESIRES POST with a Firm of Mech. Engineers. College tech. training, Mech. Eng. Diploma, 2½ yrs. shops, 1½ yr. D.O. experience, accomplished draughtsman.—Address, P178, The Engineer Office. P178 B

YOUNG ENGINEER (24), REQUIRES POSITION; well educated, good practical and tech. training, 4 years loco. shops and running, 1 year motor works; hard working, smart and businesslike.—Address, P194, The Engineer Office. P194 B

YOUNG ENGINEER (26), with University Degree WANTS POST with firm of mech. or consulting engineers; 2 years' shop experience; Grad I.M.E.—Address, P206, The Engineer Office. P206 B

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For continuation of Small Advertisements see page 3.

A Seven-Day Journal

The Prospects of Continuous Rolling.

ALTHOUGH he eulogised the principle of continuous rolling and, incidentally, reminded his audience that it is a British invention, Mr. D. L. Whitehead did not indicate any likelihood of a great extension of the process in this country, when he spoke on the subject before the South Staffordshire Iron and Steel Institute at Dudley on January 31st. This country, he said, offered little scope for the ten-stand billet and sheet bar mill, but there was room for the six-stand mill, as it could be adapted, in conjunction with a blooming mill, for the production of sheet bars within limits. As regards rods, he pointed out that the Templeborough mill—described in THE ENGINEER of June 20th, 1919—with its capacity of 100,000 tons a year, could deal with 40 per cent. of our trade. Added to this there are four other modern continuous, or semi-continuous, rod mills in the country. Mr. Whitehead thought that a very marked increase in the home demand would be necessary, coupled with a cessation of the importation of rods, before any increase in mill equipment would be justified. He also pointed out that the capital charges on a continuous mill were so high that its advantages over the older type of mill were dissipated if the output fell below 60 to 70 per cent. of the full capacity.

Flooding of the Tipton Mines.

THE report which was issued on the last day of January by the South Staffordshire Mines Drainage Commission shows that the condition of the coal pits in that district is anything but enviable. The rainfall recorded during last year at Trindle House, Dudley, was 43.71in., the greatest amount measured since the Commission was organised over fifty years ago. The result is that the water has risen in the coal mines and now submerges the thick coal by 354ft., as measured at the Moat pound, while it is only 61ft. 6in. from the pit bank. The water is thus well above the level both of the river Tame and the Birmingham Canal. At the Bradley and Deepfields pounds also the water is above the level of the river, and it is only in the Brickhouse shafts in the Oldbury district, near the fault at the boundary of the Tipton district, that the pit water is below river level, and even there the difference is only 2ft. For some time past no water has been pumped out of the mines for the supply of the Birmingham Canal.

The New London Broadcasting Station.

WORK on the new London broadcasting station, which will have twice the power of the existing station—3 kilowatts instead of 1.5—is progressing satisfactorily. Two steel lattice towers, 125ft. high, for supporting the inverted L type aerial have been erected on the roof of a London West End store and it is hoped to test the new equipment about the middle of this month. The transmitter and other apparatus have been installed in the building, but the aerial has not yet been erected. Although the distance between the two aerial masts is about 250ft., on account of the limitations imposed by the wave length of 365 m., the aerial itself will only span a distance of 70ft. It will be of the well-known double "sausage" type with 15ft. spreaders, and each portion will be composed of five wires attached to hoops 3ft. 6in. in diameter. The earth connection will be made by joining the earth lead to the main steel frame of the building.

Commercial Treaties.

THE difficulties which appear to have resulted in the complete failure of the negotiations for a treaty of commerce between France and Germany are really due to an irreconcilable opposition between two systems. When France was freed from the restrictions imposed upon her by the Treaty of Frankfort, she sought to inaugurate a new commercial policy of partial treaties, which aimed at securing from each country the maximum advantages without weakening the barriers raised for the protection of her own industries. In view of the fact that the industrial production has grown enormously during the past five years, France had little to offer for the advantages she claimed elsewhere, and she has failed to negotiate treaties except with Canada and certain small States. Even the attempts to renew negotiations with Belgium on the same lines have failed. In dealing with Germany the concessions were regarded by the representatives of that country as so wholly inadequate, in view of what was claimed for Alsace-Lorraine, that they refused to continue the negotiations, on the ground that the conditions were humiliating. Germany would not come to terms unless she were placed in the category of countries entitled to the most-favoured-nation treatment. As her new currency is stable, she finds it derogatory to be classed with those States suffering from a monetary depreciation, and she insists on taking her stand amongst the leading commercial nations of the world. This change in the German attitude is bewildering to the French, who persist in regarding the German manœuvre as something to be guarded against, and if the negotiations are continued they will decide whether or not the new French system of partial commercial arrangements will prevail over the old method of treaties of a more general character.

Modern Traffic and Railway Signalling.

THE Institute of Transport had railway signalling as its subject for discussion on Monday last, when an excellent paper was read by Major C. H. W. Edmonds. As was observed, the object of signals in the older days was to stop trains when danger was imminent, but to-day the whole trend of signalling is to keep the trains moving safely. A train standing still is losing money, as it represents so much capital lying idle. For that reason, modern signalling aims at preventing unnecessary stops and their cost. But it must not only be a money saver; it must also be a revenue earner. Major Edmonds showed that automatic signalling fulfils this double object. Power signalling, too, saves a number of signal-boxes, reduces the size of others, and by the elimination of physical effort allows the signalman to concentrate his full mental energy on his work. Many recent developments in signalling were described, and much good should result therefrom. An advantage of the Institute of Transport is that its membership includes the operating officers of railways, and it is they, more than the engineering officers, who need enlightenment as to what is now obtainable from signalling.

The Electric Lamp Industry.

ACCORDING to the *Financial Times*, the situation of the electric lamp industry, in view of the forthcoming expiry of certain of the patents under which electric lamps are made, is engaging the attention of the chief manufacturers of these articles throughout the world. For a long time past European makers of electric lamps have worked under an agreement which governed the prices charged for their products, although otherwise they were left free individually to develop their business. Some "price cutting" has, however, been experienced, and efforts have been made on the Continent to evolve a new system free from the defects of the present one. It is asserted that under the impetus of the expiration of patents the scheme is making considerable progress, and that, if and when it matures, British, American, French and German lamp makers, together with others in some of the smaller European countries, will be found working together. The new scheme, it is said, will probably be operative for ten years, will regulate not only prices but output, and may even make some arrangement for the pooling of profits.

The Steam Railway Centenary.

ALTHOUGH the arrangements for the celebration of the centenary of the opening of the Stockton and Darlington Railway in July are not yet complete, one very interesting feature in the programme would appear definitely to have been decided upon. The London and North-Eastern Railway, of which the Stockton and Darlington line now forms part, intends to form a procession of locomotives representing all the classes used on the system from the earliest types to the modern "Pacific" class. The procession will take place on July 2nd and will proceed from Stockton to Darlington by way of Eaglescliffe and Dinsdale, passing for the most part over the route of the original railway. It is understood that Puffing Billy, Locomotive No. 1, and other early locomotives will join in the procession, and that some of them may be run under their own steam. The procession will take about an hour, it is believed, to pass any one point on the route. The railway company also intends to hold an exhibition of railway articles and material at Darlington, to be opened on July 3rd.

Railway Wages.

THE demand of the National Union of Railwaymen and the Railway Clerks' Association for an all-round increase in wages has been met by the four railway groups by a counter demand for a reduction of wages. The companies propose that all grades coming under the conciliation conditions shall have an immediate flat-rate reduction in base and current rates of 4s. per week in London and industrial areas and of 6s. per week in rural areas. The existing cost-of-living scale arrangement would be retained. In a statement issued by the railway managers on Tuesday, it was remarked that before the war the total wages paid by the railway companies amounted to 47 million pounds, while to-day the figure reached 120 million pounds, representing an increase of 155 per cent. The number of men employed has also increased, but, even so, the average rate of pay of railway, according to the managers' statement, is 115 per cent. above the pre-war figure, as compared with 70 to 75 per cent. in industry generally. The demands submitted by the men would, it was remarked, involve an addition to the wages bill of 45 million pounds, and would make the total figure 250 per cent. more than the pre-war value. The companies, the managers state, are not in a position to make the concessions demanded. Such concessions would inevitably result in increased charges to the public. The men's argument for an increase would appear to rest to a considerable degree on the assumption that the grouping of the railways should, by reason of the standardisation and improved organisation which it rendered possible, have enabled the companies to effect large economies, otherwise than at the expense of wages and salaries. The position would appear to be a serious one, but it is not necessarily hopeless. It is anticipated that no decision upon the matters in dispute will be reached before the middle or the end of April.

The Mersey Tunnel Scheme.

IN a Journal note of May 9th last we published particulars of the probable cost of the Mersey Tunnel scheme, and an offer of financial assistance made by the Labour Government then in power. On Friday last Sir Archibald Salvidge, the chairman of the special sub-committee appointed by the Merseyside Municipal Co-ordination Committee, gave an account of negotiations which had been satisfactorily pursued with the present Government in connection with help for the proposed scheme. The Government, he said, was now prepared to afford financial assistance equivalent to 75 per cent. of the estimated capital outlay of £4,750,000, which represented the cost of the tunnel exclusive of the tramways. This possible grant might be conveniently grouped under four heads, namely, a capital sum of £2,375,000, representing half the cost of the scheme; interest amounting to one-half on the tramways capital outlay over a period of fifteen years, representing £400,000; the right to levy a toll for a period of fifteen years; and, lastly, one-half the approved annual cost of maintaining the road works when the tunnel was completed. The proposals indicated above constitute a considerable advance upon the assistance offered by the late Government, and Sir Archibald advised the authorities interested to accept the offer made without delay. The offer will be discussed at two meetings to be held on the 9th and 24th inst. Should the scheme go forward, the magnitude of the works to be undertaken is such that employment will be given to a large number of men, while important orders will be placed in the steel and engineering trades.

The Southern Railway and America.

TOWARDS the end of last week Major G. S. Szlumper, the Southampton docks and marine manager for the Southern Railway, left Southampton for a business trip to the United States. Before his departure, Major Szlumper stated that his primary object in going to America was connected with the development of the shipping and cargo services of the port. He proposed to visit the Great Lakes, in order to ascertain if there was anything to be learned there which might be useful in the improvement of the Southern Railway's cross-Channel services. While in America, Major Szlumper will consult with several of the chief railway authorities. In the Journal of October 17th last we outlined the ambitious programme of reclamation work and dock, jetty and warehouse extensions which the Southern Railway is to carry out at Southampton. In this connection it is hoped that one of the results of Major Szlumper's American visit will be the establishment of a new factory at Southampton.

State Control of French Railways.

THE refusal of the French railway companies to reinstate all the men who were discharged at the time of the great strike in 1920 is probably the reason that has prompted the Minister of Public Works to prepare a Bill that aims at subjecting the appointment of all railway officials to the approval of the Government. The companies went so far as to reinstate men who appeared to offer some guarantee of good behaviour, but they refused to re-engage those whom they regarded as likely to provoke disorder. Not satisfied with this concession, the Minister insisted on the companies taking back all the men who applied for reinstatement, notwithstanding that after such a long period those worth anything at all would already have found situations elsewhere. The Minister threatened to take such measures as would compel the companies to execute his orders, and if the proposed Bill is carried through Parliament, there is no doubt that the railway companies will be made completely dependent upon the Government. There is no lack of argument, however, to show that Parliament cannot destroy the self-governing status of the railway companies. The proposed Bill is evidently an attempt to introduce the thin end of the wedge for the nationalisation of all the railways. The idea of State control had been completely rejected until the present Socialist Government came into power, but despite the facility with which such a Bill would probably pass through the Chamber of Deputies, the economic consequences would be so serious that it may not be introduced at all. In any case, it would certainly be rejected by the Senate.

The British Steam Railway Locomotive from 1825 to 1924.

By E. L. AHRONS, M.I. Mech. E.

No. VI.*

PERIOD 1837 TO 1841 (*continued*).

Coupled Engines with Inside Cylinders.—Before considering other types of 2–2–2 engines mention may be made of some of the coupled engines of the period. Until 1837 these were of the 0–4–0 and its derivative, the 0–4–2 types. In 1837 R. Stephenson and Co. introduced the 2–4–0 type, as shown in Fig. 33, and two engines were exported to America and two to the Paris and Versailles Railway. The coupled wheels were 4ft. 6in. diameter and the cylinders 15in. by 18in. In these engines the dome was brought further forward and the regulator was placed in the smokebox. The small size of the leading wheels, 3ft. 6in. diameter, allowed the cylinders to be placed horizontally, a great improvement upon the previous

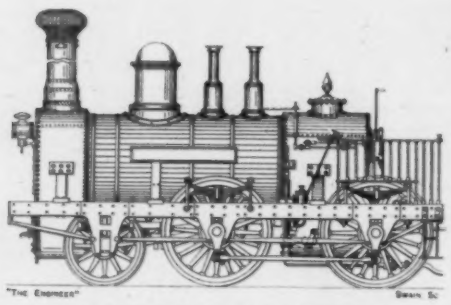


FIG. 33—STEPHENSON'S 2-4-0 ENGINE, 1837

clumsy arrangement with slide bars below the leading (coupled) axle. The 2–4–0 type did not come into use in this country until about two years later, when a number of engines were built for the Great North of England Railway.

A noteworthy detail in all these coupled engines was the extreme length of the outside cranks and consequent throw of the coupling rods. With a stroke of 18in. and 9in. inside cranks the outside cranks were 14in. and in some cases 15in. long. The writer has never seen any account which gives a reason for this proportion. It may be that the designers of those days thought that the momentum of a rod with a long throw would better carry it over the dead centres, more especially as the engines were intended for slow-speed goods traffic. But even as late as 1857 there were some examples of coupled passenger engines in which the throw of the coupling rods was excessive.

The 0–4–2 engine—Fig. 34—built by Messrs. Hawthorn for the Newcastle and North Shields Railway

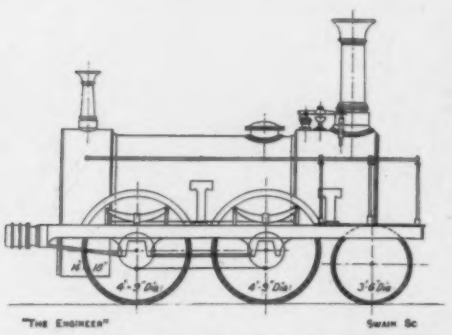


FIG. 34—HAWTHORN'S 0-4-2 STEAM DRYER LOCOMOTIVE

in 1840, presents the peculiarity that the chimney is at the footplate end. It had a return-tube boiler with double fire-box, the latter being divided into two portions with semi-circular crowns and a water space between them. It had also a superheater or steam dryer, which consisted of a steam chamber in the upper part of the smoke-box with connections to the cylinders. The furnace gases on their way to the chimney passed through a number of vertical tubes in the chamber. This appears to have been the first actual application of a superheater to a locomotive.

On the Stockton and Darlington Railway the 0–4–0 type of engine with inside cylinders was used for passenger trains, and W. and A. Kitching's engine Queen, built in 1837 for this line, was described and illustrated in THE ENGINEER, October 29th, 1920. This engine, which had 4ft. 6in. coupled wheels and 12in. by 18in. cylinders, was subsequently converted to the 0–4–2 type. Hackworth's 0–4–0 engine Dart of 1840, unlike the Queen, had inside bearings, 13in. by 16in. cylinders, and 4ft. 6in. wheels. The boiler carried a pressure of 70 lb. For a passenger engine it had an extremely short wheel base of 4ft. 10in. only, with an excessive overhang at the back end.

The six wheels coupled engine made very little progress during this period, and it was not until 1843 that its use for goods traffic extended. Two 0–6–0 engines by Tayleur, 1835, and the Haigh Foundry, 1839, similar to Stephenson's previous design, were put into service on the Leicester and Swannington Railway. They were, for that period, extremely powerful engines, having 16in. by 20in. cylinders and 4ft. 6in. wheels.

Outside Cylinder Engines.—In 1839 there appeared a number of outside cylinder locomotives of somewhat more modern type than Forrester's outside-framed engines. In the new engines the frames were inside and the crank pins were fixed in the wheels. The earliest of this type were built in 1839–40 for the Arbroath and Forfar Railway (Fig. 35) by Messrs. Stirling, of Dundee, where Mr. Patrick Stirling served his time under his uncle, who was the principal in the firm. The cylinders, 13in. by 18in., were steeply inclined at 1 in 4½ and had valves on the top worked by rocking shafts. The casting for the guide bars was also unusual. The driving wheels were 5ft. diameter and carrying wheels 3ft. 6in. diameter. The pressure appears to have been 50 lb. The Glasgow, Paisley, Kilmarnock and Ayr Railway also had a number of somewhat similar engines from other Scotch firms in 1840–1, but with horizontal cylinders and 5ft. 6in. driving wheels.

The engine shown in Fig. 36 forms a landmark in locomotive design, and was the first to have outside horizontal cylinders with rods working directly on to crank pins in the driving wheels, in combination with inside bearings and four coupled wheels. Two of the type were built by G. and J. Rennie, of Blackfriars, London, the first of which was put to work in September, 1838, on the London and Croydon Railway for banking trains up the New Cross incline of 1 in 100. Both inside and outside frames were of the sandwich type with 3in. thickness of timber between them. The outside cylinders were attached to both frames.

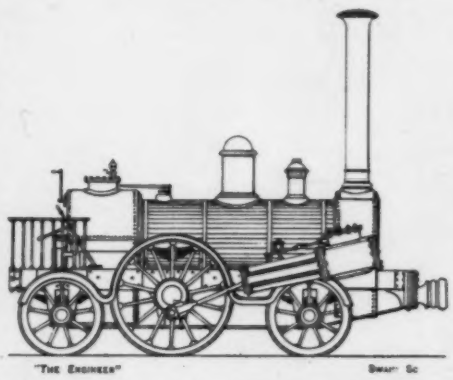


FIG. 35—STIRLING'S 2-2-2 OUTSIDE CYLINDER ENGINE

The steam chests were above the cylinders and the valves were worked by rocking shafts. The feed pump was placed underneath the left-hand cylinder and worked from a lug on the crosshead. The fire-box was oval in section with the larger diameter transversely. The driving wheels were flangeless and the trailing wheels had bearings in the outside frames only. The engines therefore had "mixed" framing and were the first of this type. The cylinders were 13in. by 18in., coupled wheels 5ft., and the trailing wheels 3ft. 6in. diameter. The oval fire-box was 3ft. by 3ft. 7in. Weight of engine in working order 14¼ tons. This type of outside cylinder 0–4–2 engine, originated by Messrs. Rennie, never took root on English railways, on which the total number at no time exceeded half-a-dozen at the most. But some years later it was taken up by the Scottish locomotive engineers, beginning with Robert Sinclair in 1847, followed in 1855–6 by Neilson and Co., Alexander Allan, and Patrick Stirling, and became a standard type, of which several hundreds were built down to 1881 for goods and mineral traffic over the Border.

The name of Alexander Allan is connected with the well-known "Crewe" type of outside cylinder engines, and although the original design had its inception at the end of 1840, it will be more convenient to consider it during the next period.

Norris American Type Engines.—These were first imported in 1840–1 for the Birmingham and Gloucester Railway, and were of the outside cylinder 4–2–0 type. They had leading bogies with cast iron wheels 2ft. 6in. diameter, the bogie wheel base being 3ft. only. The driving wheels 4ft. diameter—in some engines 4ft. 3in.—were placed immediately in front of the fire-box. The latter was of iron and of D section as in Bury's engines, and the bar frames were also very similar to those of Bury's design. Many parts, such as slide bars, were of cast iron. The cylinders in the eight original engines were 10½in. by 18in., but in later engines, both by Norris and two British firms, were increased to 11½in. and 12½in. diameter by 20in. stroke. They were somewhat steeply inclined, and secured partly to the frame bar and partly to the smoke-box. The weight varied from 9½ tons in the earlier to 13 tons in the later engines. An illustration of one of the similar British built engines was given in THE ENGINEER, July 30th, 1920, page 103.

It has been generally supposed that these engines were employed exclusively on the Lickey incline of 1 in 37; actually they were used for the whole of the ordinary passenger and goods traffic between Birmingham and Gloucester, the mail and express trains alone excepted. An extra bank engine of the same class assisted the trains up the Lickey. At least 14 engines were built by Norris in Philadelphia, and there were also nine others by the Lancashire firms of Nasmyth, Gaskell and Co., and B. Hick and Co. Why American engines were imported it is difficult to say, though the Norris engines had been given a reputation for incline work in America which had attracted the attention of Captain Moorsom, the company's engineer. Colburn ("Locomotive Engineering," p. 52) throws some doubt upon their performances in America, and points out that unless the steam pressure had been 90 lb. instead of 60 lb. as given, their advertised feat could not have been accomplished.

In the obituary notice of Captain Moorsom ("Proc."

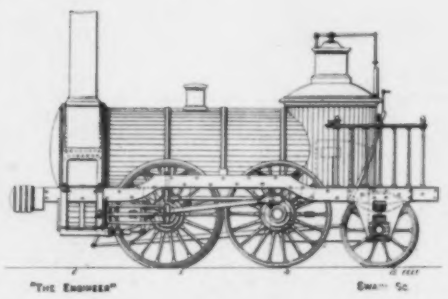


FIG. 36—RENNIE'S 0-4-2 OUTSIDE CYLINDER ENGINE

Inst. C.E., Vol. 23, p. 501) it was stated that both Stephenson's and Bury's firms had declined the task of supplying locomotives for the Lickey. For negotiating the Lickey the Leicester and Swannington 0–6–0 engines would have probably been preferable, and were certainly more powerful. Mr. J. E. McConnell, who was locomotive superintendent of the line from 1841, stated that the Norris type engines were too light. Most of them were subsequently converted to saddle tank engines, and the design had no influence on subsequent British practice.

John Gray's Express Engines with Mixed Frames.—Before completing the account of progress during this period, special mention must be made of the 2–2–2 express engines, designed by John Gray, and built by Shepherd and Todd of Leeds in 1840, for the Hull and Selby Railway, of which he was locomotive superintendent. They, together with Gooch's contemporary Great Western engines, mark the first entry of the railway locomotive superintendent, into the design of engines. Gray's locomotives

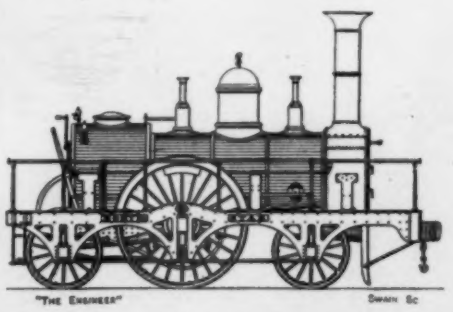


FIG. 37—G.W. RAILWAY NORTH STAR, BROAD GAUGE

were recently illustrated in THE ENGINEER, October 15th, 1920, page 370, to which reference may be made. The type was that of Stephenson's patented six-wheeled engine with horizontal inside cylinders, but the frames and most of the details were entirely different. The framing was of the "mixed" type with inside bearings only for the driving axles, the leading and trailing axles having bearings in the outside frames. The driving wheels had the large diameter of 6ft., and the cylinders were 12in. by 24in. in the first engines, and 13in. by 24in. in two similar engines built for the York and North Midland Railway. The engines were fitted with Gray's patent expansion gear, known as the "horse-leg" motion, illustrated in D. K. Clark's "Railway Machinery," page 25, and in Colburn's "Locomotive Engineering," page 59. This was the earliest form of expansion gear used in locomotives, and had previously been tried in 1839 on the Liverpool and Manchester Railway. The reversing lever had a notched sector. The valves had a very long travel, about 6in. in full gear, the lap being 1¼in. and the lead ⅛in. The boiler had two domes, one over the fire-box and the other on the middle of the boiler. Both had vertical steam

* No. V. appeared January 30th.

collecting branch pipes, the one in the rear dome being somewhat smaller in diameter than that in the other. Both branches joined a main horizontal steam pipe, at the end of which the regulator was placed in the smoke-box.

John Gray was an engineer who had sound ideas considerably ahead of his time. He increased the boiler pressure of his engines to 90 lb. and, shortly afterwards, in his goods engines to 100 lb. Moreover, at the time when all locomotive engineers were doing their utmost to keep the centre of gravity as low as possible, Gray appears to have been alone in realising that it was unnecessary to do so. In the passenger engines described above the centre of the boiler was 6ft. 2in. above rail level, a height about 4in. greater than that of the few standard gauge inside cylinder engines which then had 6ft. wheels, and, of course, considerably greater than that of the average engines, the driving wheels of which were only 5ft. 6in. In the outside cylinder engines of the London and South-Western Railway, built in 1843, with driving wheels of the large size of 6ft. 6½in., the boiler centre was only 5ft. 2⅝in. above rail level. When questioned on the subject in 1845 before the Gauge Commissioners, Gray replied that he did not wheels were 5ft. in diameter and the cylinders 11in. by 18in.

THE BROAD GAUGE ENGINES OF THE GREAT WESTERN RAILWAY, 1837 TO 1842.

Early Engines, 1837–8.—Although the Great Western Reilway was not opened until June, 1838, some of the locomotives, including one dated 1837, had been delivered some time previously. With one, and possibly two exceptions, they formed the most extraordinary collection of freaks. It is not necessary to describe them in detail, since they had no influence on the development of the locomotive, but a few words concerning them will not be out of place.

Six 2–2–2 engines, built by Tayleur and Co., had 8ft. driving wheels; three of them had 14in. by 16in. cylinders, and three others 12in. by 16in. cylinders. As the steam pressure was about 50 lb. to 55 lb., and the total heating surface about 500 square feet, they must have been hard put to it to keep themselves in motion, even without a train. Nevertheless, with the exception of two Stephenson locomotives, they were stated to have been the best of a queer lot. In these and other engines the driving axles had the horns and axle-boxes placed above the framing.

with the designs, and that he was very uneasy about their working. Brunel stated that he sent out no specifications and neither compelled nor induced the makers to adopt certain dimensions or modes of construction. On the other hand, makers, such as Tayleur, who had been building standard gauge engines with 5ft. 6in. wheels and 13in. by 16in. cylinders, must certainly have had sufficient knowledge of the effect on the tractive force of large 8ft. wheels, without making matters worse by the use of cylinders only 12in. by 16in. Long before 1837 these facts were known and recognised. Brunel himself admitted before the Gauge Commission in 1845 that the original intention had been to employ large wheels of 7ft. to 8ft. diameter, and therefore it seems to the writer that he probably interfered in some way and was not entirely blameless.

Stephenson's "Star" Class.—The only successful Great Western Railway early engines were built by R. Stephenson and Co., and were named North Star and Morning Star. The former is shown in Fig. 37. It was originally intended for the New Orleans Railway, U.S.A., of 5ft. 6in. gauge, but was altered to suit the 7ft. gauge. It was built in 1837, tested on the Great Western Railway early in 1838, and worked the first passenger train out of Paddington on June 4th, 1838, when the railway was opened.

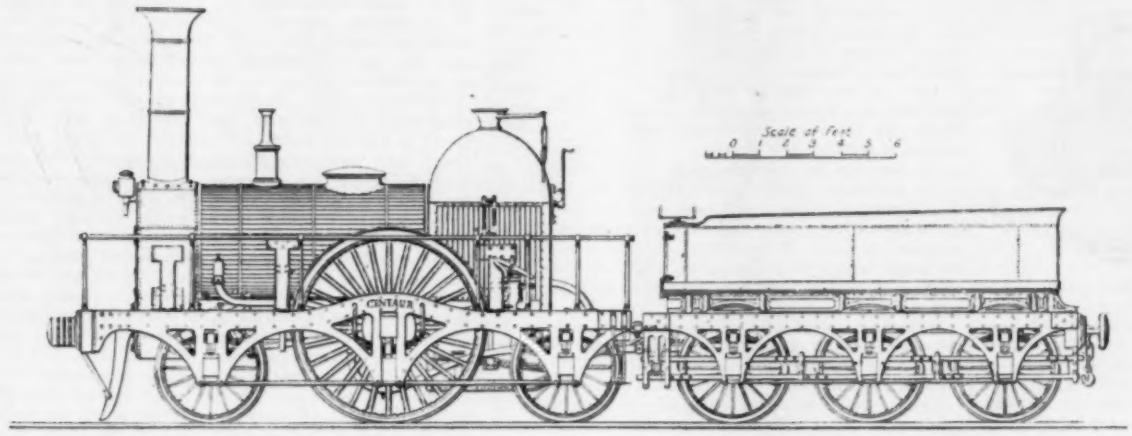
The driving wheels were 7ft. diameter, and the cylinders 16in. by 16in. According to Whishaw, the fire-box heating surface was 66.16 square feet, and the tube heating surface 640 square feet, calculated on the fire and not on the water side. Warren, page 341, states that the boiler barrel, 8ft. 6in. long by 4ft. diameter, contained 107 1⅝in. tubes, and that the total heating surface was about 711 square feet. The last figure agrees very nearly with Whishaw, but it is not stated whether fire or water side surface is intended. The wheel base was 7ft. + 6ft. 4in. = 13ft. 4in.

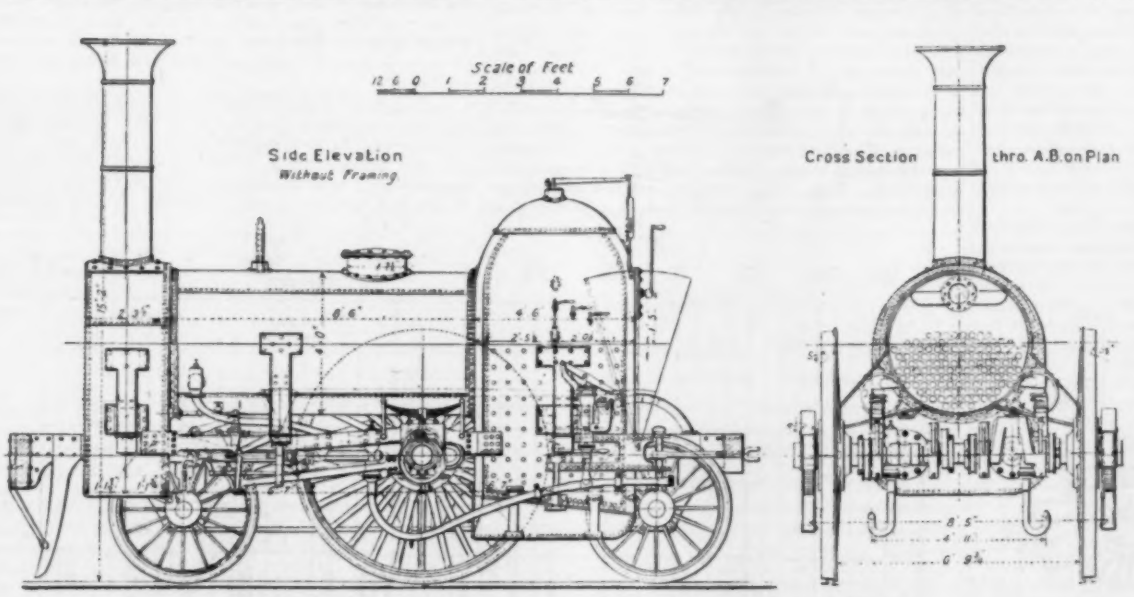
The Morning Star was a somewhat similar engine, but the driving wheels were only 6ft. 6in. diameter.

The North Star was a very successful engine. In 1854 it was re-boilered at Swindon with a domeless boiler, the cylinders at the same time being enlarged to 16in. by 18in., and in this form with the original framing it continued at work until December, 1870. The total heating surface of the new boiler was 850 square feet, of which the fire-box surface was 94 square feet. The engine was preserved at Swindon for many years.

Messrs. Stephenson subsequently, in 1839 to 1841, built ten other engines of the "Star" class, with 7ft. driving wheels, the cylinders varying from 15in. by 18in. in two of the 1839 engines to 15½in. by 19in. in the last two built in 1841. All these engines had "Gothic" domed fire-box casings instead of the original round topped raised type of the North Star. They also had six bearings, two outside and four inside, for the driving axles.

The inside bearings were held in stay plates, which extended between smoke-box and fire-box casing.





FIGS. 38 AND 39—G.W. LOCOMOTIVE "CENTAUR," ELEVATIONS AND SECTION

care much about the centre of gravity. It was about ten years after the construction of the Hull and Selby engines before other engineers, beginning with McConnell, gradually broke away from the deeply rooted theory of a low centre of gravity. This theory, as will be shown, very greatly affected locomotive design during the period 1842 to 1850.

Tank Engines.—Tank engines, if Blenkinsop's and the later Braithwaite and Ericsson trial engines of 1829–1830 be excepted, first made their appearance about 1837. An experimental four-wheeled express tank engine, with large driving wheels 6ft. 2½in. diameter, was constructed by Dr. Church, of Birmingham. The cylinders, 11½in. by 20in., were outside and placed under the footplate, and the driving wheels were under the boiler near the front of the engine. The small carrying wheels were at the trailing end. This engine is illustrated in D. K. Clark's "Railway Machinery," page 14.

But the first two tank engines to run regularly on a public railway were the "Victoria" and "Comet," built by Forrester and Co. for the Dublin and Kingstown Railway. The writer does not know the exact date when they were built, but they were probably contemporaneous with Church's engine. They were four-wheeled engines with outside cylinders and frames, similar to the "Vauxhall"—Fig. 23, *ante*—with the addition of tanks underneath. The driving

Then there were two 2–2–2 engines by Mather, Dixon and Co., stated to have had 10ft. driving wheels and cylinders 14in. by 20in. Their main characteristic was that all the wheel centres, including the 10ft. drivers, were built up of riveted plates in the form of discs. Whether they ever worked any trains in their original form is doubtful, and by 1840 they appear to have had the wheels reduced to 8ft. diameter, the size recorded in Whishaw's "Railways of Great Britain and Ireland."

There was also another engine with 10ft. driving wheels, on T. E. Harrison's patent, with the engine and machinery on one frame, which formed a separate carriage from that on which the boiler was placed. This engine, which had 16in. by 20in. cylinders, was built by Messrs. Hawthorn. Another Harrison engine by the same firm had 6ft. coupled wheels geared up by means of spur wheels in the ratio of 3 to 1, the equivalent of driving wheels 18ft. in diameter. Illustrations of some of the above engines will be found in THE ENGINEER Supplement of December 16th, 1910, and a full illustrated account of all of them in the *Locomotive Magazine*, Vol. VI., 1901.

The responsibility for the design of many of these freaks has never been cleared up satisfactorily. They were mostly ordered before Sir Daniel Gooch took charge of the locomotive department, and in his diaries it was stated that he was not very pleased

D. Gooch's Engines.—When Sir (then Mr.) Daniel Gooch decided to make his own designs for the Great Western Railway, he took Stephenson's "North Star" type as a pattern, but enlarged the dimensions. The drawings were made at Swindon, and for the first time in history we meet with standardisation on an extensive scale for an individual railway. Full specifications and templates were supplied to each manufacturer to ensure interchangeability.

Of the new locomotives (1840–1842), there were sixty-two express engines. They are shown in Figs. 38 and 39, by kind permission of Nasmyth, Wilson and Co., Limited, Manchester, who as Nasmyth, Gaskell and Co. built sixteen of them. As originally made, the cylinders were 15in. by 18in., though about ten years later they were enlarged to 16in. by 20in. The driving wheels were 7ft. diameter, carrying wheels 4ft. diameter, and wheel base 13ft. 2in. equally divided. In spite of the breadth of the gauge, the boiler was only 4ft. diameter, and contained 131 2in. tubes, but the fire-box casing was 4ft. 8½in. wide by 4ft. 6in. long. Heating surface of tubes, 557 square feet, of fire-box 90.6 square feet; total, 647.6 square feet. Weight in working order, about 24 tons. All these engines were direct derivatives of Stephenson's North Star, and had a similar pattern of outside framing and centre stay bear-

ings. The engines were built by the following makers :—

Jones, Turner and Evans, Newton-le-Willows ..	6
Sharp, Roberts, Manchester	10
Fenton, Murray and Jackson, Leeds	20
Nasmyth, Gaskell and Co., Manchester	16
R. B. Longridge and Co., Bedlington	6
Stothert and Slaughter, Bristol	2
G. and J. Rennie, London	2
	62

A smaller type of 2–2–2 engine was built for local and branch line passenger trains. They were similar in appearance, but had 6ft. driving wheels and 14in. by 18in. cylinders (three 15in. by 18in.), but the wheel base, for some unknown reason, was 13ft. 8in., or 6in. longer than that of the express engines. There were twenty-three of this class by Hawthorn (eight), Sharp Roberts (five), and Stothert and Slaughter (eight). They were used on the Bristol and Exeter Railway, but their adhesive weight was deficient,

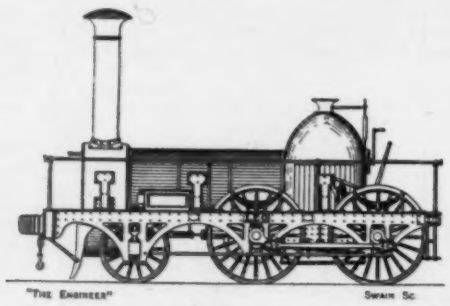


FIG. 40—G.W. LOCOMOTIVE "LEO," 1841

and consequently they were afterwards converted to saddle-tank engines.

The first eighteen goods engines of 1841–2 were of the 2–4–0 type (Fig. 40). They had 5ft. coupled wheels and 15in. by 18in. cylinders. Finally there were built four 0–6–0 engines (Fig. 41). They came from the works of Nasmyth, Gaskell and Co. in 1842, and were an afterthought on the part of Gooch, who had ordered 7ft. express engines, but subsequently, wishing to try six-coupled goods engines, altered the order. They had 16in. by 18in. cylinders, 5ft. wheels, and 12ft. 6in. wheel base. The boilers were similar to those of the express engines.

The usual pressure of all Gooch's early engines was 50 lb. per square inch, but there are reasons for believing that a few of the express engines carried 55 lb. pressure.

No broad-gauge engines were built between 1842 and 1846.

Outside Sandwich Frames on the Great Western Railway.—The peculiar type of outside sandwich framing originally by Stephenson should be noticed.

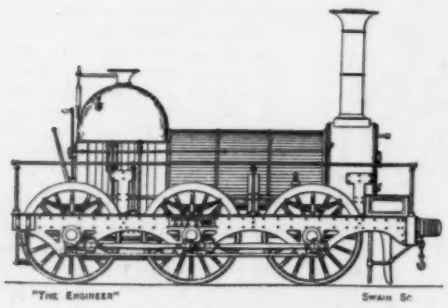


FIG. 41—G.W. LOCOMOTIVE "TITYOS," 1842

The triangular apertures were probably cut out to lighten it, and in all of Sir Daniel Gooch's engines, both broad and standard gauge, until 1865, this form of framing was employed. In 1872 it was again taken up, and a large number of standard gauge engines were built until 1891, when it was abandoned. The technical history of sandwich framing, more especially on the Great Western Railway, is of interest. Originally ash was the wood used in many engines, but subsequently not only the Great Western, but also the private locomotive builders, employed oak as the strongest timber obtainable, and this continued to be the practice for many years. But one disadvantage of this type of frame was that the bolts, of which a large number were necessary to secure the flitch plates to the timber, tended to work loose. It was found during Mr. Dean's superintendency that the acid existing in the oak caused the bolts to corrode. Afterwards in the later engines of 1886 to 1891 teak, an oily wood, was substituted and trouble from this cause ceased.

The use of sandwich frames on the Great Western Railway long after all other companies and locomotive builders had discarded them was largely due to the longitudinal sleeper road, of which even at the time of the abolition of the broad gauge in 1892 there were many miles, not only on the main line to Penzance, which was laid entirely on that system, but also on much of the South Wales, Weymouth and Birmingham sections. It is an undeniable fact, to which the writer can testify from considerable experience on the footplates of both sandwich and solid plate framed engines, that the former ran much more smoothly and with less vibration on the longitudinal sleeper road. The difference was extremely marked, and was even noticeable, though to a considerably less extent, on the ordinary cross sleeper road. The "baulk" road, as the drivers used to term it, was very "dead." For this reason the Great Western also used longer springs than other companies, and many of them were of the "open plate" type, in which each long main plate was separated from the one next to it by a short thin plate.

The Influence of Pulsations on Combustion.

By J. DESCHAMPS.

IMAGINE a particle of carbon suspended in still air. Imagine also that gravity has no effect upon it. If the conditions of temperature and pressure are suitable, combustion will begin upon the whole surface, but the carbon will be immediately isolated from the air by a layer of cinders and a layer of burnt gases, from which it cannot escape because gravity is assumed to have no effect and the air is perfectly still. Hence combustion will be stopped. Note also this important point that the same result will arise if a particle of carbon is carried in a current of air at precisely the same velocity as the air itself. This effect must occur, no matter what the velocity may be. In order that combustion may continue, it is necessary that there should be relative movement between the air and the carbon. Without it, only the volatile products can escape from the carbon particle through the coating of cinders, and may burn if the air supply is sufficient.

In practice, this relative movement is effected by the obstacles in the path of the burning gases by changes of volume and of pressure in the gas at different points and by difference of pressure or velocity, produced either naturally or artificially by pulsations. The efficiency and satisfactory action of a furnace depend in the first place on the completeness with which the air is brought into contact with the largest possible surface of the combustibles, and regularity of combustion on the whole surface of the particle is specially good when the combustibles are gauged to a standard size, and contain a small amount of ash, so that the air passages between the particles of carbon may be practically equal throughout the whole mass. Unfortunately, this condition is unstable. The gauging of the particles of combustibles is never perfect; with the consequence that the air passes more freely through those spaces which are largest, and with the further result that the size of the spaces increases as still more air passes. If the coal contains a large proportion of ash the walls of the fragments of coal are soon reduced to nothing but clinker, then the air ceases to burn the carbon, and is carried up to a higher zone. In this manner "chimneys" are formed through the bed of fuel, through which air passes unchanged. In some cases this heated air finds unburnt volatiles and ignites them, with useful effect. In gas producers these chimneys may have a serious effect, which can only be obviated by hand poking in order to stop up the air passages. It is for this reason that carefully gauged fuel, and fuel that is free from ash, gives the best result with automatic regulation and poking. It is impossible to prevent the formation of the chimneys through the fuel, and the best that can be done is to limit their existence to as brief a period as possible.

Now, in general, a piece of coal is burnt only on a small part of its surface, actually on that part which is rubbed by the principal current of air or by eddies. In other places where air has not free access to the coal, combustion is incomplete. This condition holds good, however great the draught may be, for it must be noted that along the principal canals formed through the mixture will pass the mixture of air with already partially burnt gases, whilst the lateral branches from the main canals only receive their supplies of air from the horizontal movement of the eddies and the partially burnt air is too weak in oxygen to support combustion. It is for this reason that the output in a gas producer is not in direct proportion to the draught.

To excite combustion, it is therefore necessary to produce lateral movements of the air between the particles of coal, and it is evident that one way of causing the air to enter the laterals is to reduce the draught. If the draught is very feeble the air remains in the spaces, because the effort exerted by the draught is too small to displace it. Under such conditions, the expansion, the rise of pressure, and so on, produced by combustion itself, all help to drive the air into the lateral passages. Such means have been successfully employed in the past in many gas producers, but, unfortunately, they necessitate the use of producers of large size, and nowadays the whole trend is towards intensive output. It would seem, then, that there are only two means of satisfying modern conditions—movement in the lateral passages between the particles of fuel can only be effected if differences of pressure exist in the burning mass. Hence, one way would be to admit air through the grate at different pressures at different places, or alternately, in large gas producers, which are blown through tuyeres, to employ different air pressures in the tuyeres and to change these pressures frequently. Clearly, it would be very complicated to have air supplies at different pressures to the tuyeres, but the same end may be reached by periodically closing this or that air passage. By the employment of such pulsations of air, waves of pressures are set up throughout the mass of fuel, and the air is driven hither and thither between the lumps of fuel. Thus it comes about that the chimneys referred to above do not form, and that the coal is burnt with much greater uniformity.

Let us now consider the case of powdered combustibles carried in suspension in air. In this case, too, the phenomena are the same. Here, also, it is not the actual speed of the air which encourages combustion; it is the relative speed of the air to that of the combustible which matters. If the relative speed of the air and of the particles of carbon is continually changing, the film of burnt gases charged with distillates is carried away, and new air reaches the particle of carbon. It may be observed that the speed of the particle of carbon will change with that of the air, but that is true only in part, as the inertia of the particle must be considered, and, moreover, the act of combustion sets up lateral movements of the particle on its own account. It is for that reason that temperature has such an important influence on the activity of combustion. These rapid pulsations play their part by modifying continuously the conditions of combustion, and by attacking the dynamic equilibrium, which, as a consequence, is only able to persist for relatively short periods. In some remark-

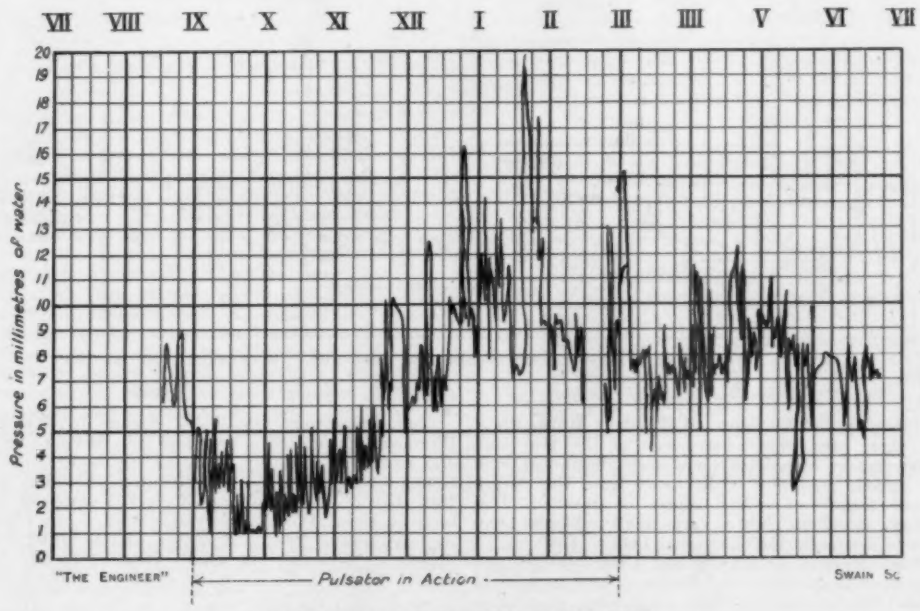

VII VIII IX X XI XII I II III IIII V VI VII
Pressure in millimetres of water
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
"The Engineer"
Pulsator in Action
Swain Sc

FIG. 1—RECORD OF PRESSURE IN GAS MAIN

able experiments on the combustion of powdered fuel in suspension, carried out by Messrs. Taffanel and Audibert, certain tests were made in a tube in which the speed of combustion increased regularly up to the point where an undulatory movement of a frequency compatible with the characteristics of the tube was reached. At that moment the speed of combustion increased much more rapidly and irregularly. Indeed, the combustion became explosive. It would be interesting to discover if artificial vibration of the tube, as, for example, by rubbing it, would set up these oscillations and accelerate combustion. In any case, the experiments of Monsieur Audibert at Montlucon have shown variations in the length of the flame between 15 and 50 per cent. as the pulsations varied between 700 and 2100 per minute, but these figures must be regarded with some reserve, for, so far, we have nothing to indicate that 50 per cent. is the maximum, and it may certainly be said that the frequency of the pulsations must depend upon the speed of the air charged with carbon and upon other characteristics.

This shortening of the flame of powdered coal or of other combustibles by vibrations is of the first importance, for, in the first place, it indicates that good combustion without excessive air is being attained. When a flame is short the burnt particles are at a high temperature. To direct such flames on to refractories would be dangerous, but it is precisely because the flame is short that it is easy to localise it, and, moreover, a short flame is more stable and its length varies less than does that of a long flame. Hence one may employ a much shorter furnace with less danger to the walls, which, moreover, may more easily be protected, since as combustion is complete before the flame reaches the wall, the walls may be effectively cooled without arresting combustion. For this reason it must not be objected that the high temperature of short flames is a disadvantage. It is for engineers to devise means of employing them.

But to return to combustion in ordinary furnaces. I have made some experiments on a gas producer of the Bouchayer-Hilger type, 2.5 m. in diameter at grate level. Fifty pulsations a minute were given, the pulsations being divided in a rhythm of four. During the first two air alone was blown in, during the third air and steam were introduced together, and the pressure on the grate—which in the two proceeding phases was that due to the draught alone—increased owing to the pressure of the steam. During the fourth phase, air and steam were stopped altogether, and the pressure on the grate fell rapidly until it became equal to that in the delivery main. It must be understood that these differences of pressure are, as a fact, very small, not more than 1 per cent. of the prevailing pressure. Nevertheless, the result was absolutely conclusive and fulfilled my prevision. In Fig. 1 is given an autographic record of the pressure in the gas main at a place about 50 m. from the producer. Before the pulsations were applied the pressure oscillated between 5 mm. and 10 mm. As soon as the pulsator was started the pressure fell considerably, because the zone of combustion was not modified, whilst the air was stopped once in four, and that of the steam three times out of four. But it must be observed that, with the same blowing pressure, the pressure rose slowly and regularly until it far surpassed the preceding pressures. Quite a considerable time passed before this effect became noticeable—about three hours with air and steam and six hours with air alone. Successive tests all gave similar results. Comparative tests which have been made at Commentry with coal having a high percentage of ash, alternatively with and without pulsations, have shown a considerable economisation of coal. The consumption of steam is also considerably reduced because the steam jets only open once in four. Poking is also reduced, and, as a matter of fact, it was impossible to employ coal of the kind without pulsations. Fig. 2 shows the type of pulsator employed for gas producers, and requires no explanation. Preparations have been made in France to carry out a test on a blast-furnace with interruptions of the blast successively in the tuyeres. Tests are also to be made in Belgium on a coke furnace, and further tests will be made with pulverised coal.

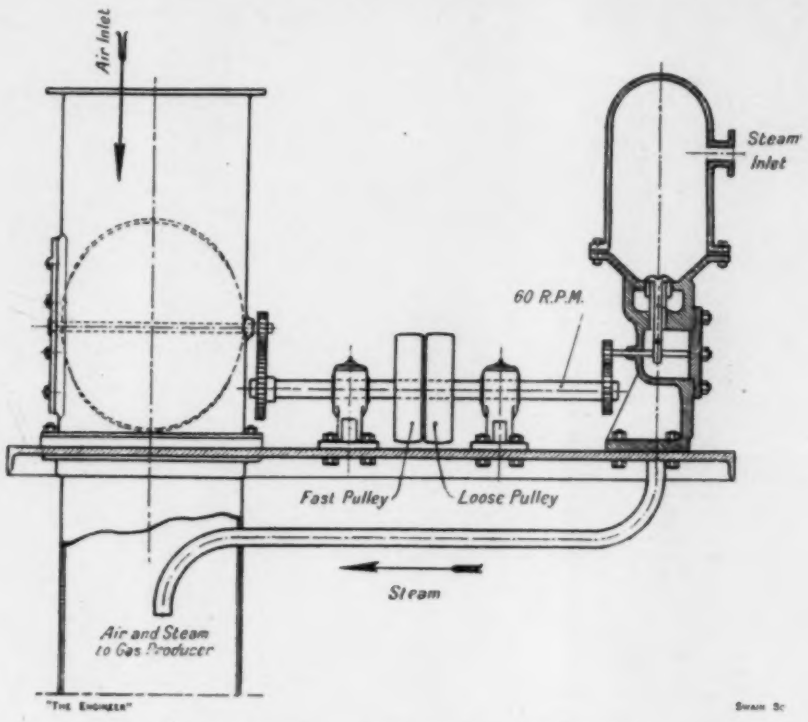


FIG. 2—PULSATOR FOR USE WITH GAS PRODUCERS

The object of this short article has been to exhibit the phenomena of combustion and the advantages that are obtained by setting up pulsations and vibrations in the gaseous flames.

French Locomotive Performances.

By J. T. BURTON ALEXANDER.

SINCE my last runs—see THE ENGINEER, August 3rd, 10th, and 17th, 1923—I have been enabled to make some further trips, which show steady progress towards the pre-war expresses, and I will take the lines as they come in the official Chaix Time-table.

On the P.O. in 1923, in holiday time, with every train doubled and some specials as well, during the hot weather, with a load of eleven coaches, weighing 429 tons, packed with passengers, engine No. 3527 passed Juvisy at the reduced speed of 34 m.p.h., after having attained 49.7 m.p.h. in 17 min. 45 sec., Bretigny at 45.9 m.p.h. in 28 min. 40 sec., Etampes in 46 min. 15 sec., after having reached 57.1 m.p.h., Toury in 72 min., climbing Etampes bank at a minimum of 32.9 m.p.h., and reached Les Aubrais in 93 min. 50 sec.

This engine was fitted with an exhaust injector, and at the top of Etampes bank she was full of water and blowing off with the injector on. From Chateauroux, with the same load and No. 4590, we touched a speed of 62.1 m.p.h. before a signal stop at Argenton, with an admission of 60 and 70 per cent. in the high and low-pressure cylinders and 45 lb. pressure in the low-pressure receiver. We reached Argenton in 24 min. 40 sec., and, starting from there, we were stopped on the bank of 1 in 100, and on re-starting attained a speed of 26 m.p.h. before the top, and from another signal stop we reached a speed of 32.3 m.p.h. before breasting the top of this bank of 1 in 100. From La Souterraine to Bersac, start to stop, 12.4 miles over the undulating table land, only 16 min. 30 sec. were taken, with a minimum speed of 48.4 m.p.h. This was one of the finest efforts I have noted for a long while against constant signal delays, the engine being magnificently handled, both by the driver and fireman.

South of Brive we had an overload of 10 per cent., and the tropical heat had so heated the rails, wheels and every metallic object that even with the steam sanding we had trouble from slipping up the long banks of 1 in 100.

On the same line in winter, on the up Toulouse day express, which was heated, engine No. 4558, with eight cars = 315 tons, we passed Caussade, from Montauban, in 22 min. 45 sec., never dropped below 34.7 m.p.h. up the long 1 in 100 and stopped at Cahors in 58 min., and from Souillac, starting on the 1 in 100, accelerated to 38.6 m.p.h. at the top, in spite of drenching rain and wind, and with the load increased to eleven coaches = 440 tons from Limoges, reached Paris punctually, making up time lost by permanent way repairs.

On a down Toulouse day train in November, engine 3639, an American-built 4–6–2, with eleven coaches = 440 tons, left Les Aubrais 13 min. late, owing to signal delays, and passed St.-Cyr-en-Val in 10 min. 30 sec., Vouzon in 24 min. 15 sec., Theillay in 49 min. 30 sec., and stopped at Vierzon in 57 min. 45 sec., after the usual easy approach, and ran on to Chateauroux in 51 min. 40 sec., including a long dead slow for a new bridge at Issoudun. The weather was bad, with side gale and rain.

Since the war a new class of 2–8–2 engines, simple superheaters, built in America, has been placed in service for fast goods trains and the passenger trains on the old line from Brive to Toulouse, *vid* Capdenac, with its curves and constant gradients of 1 in 80. The trains now stop at most of the stations, but the night trains to and from Paris often load to between 300 and 413 tons. The coal in this district is none too good, and the maximum speed allowed is only 43.4 m.p.h. between Brive and Capdenac, and 40.3 on to Toulouse. Climbing the bank from Figeac to Assier, with a load of eleven coaches, 300 tons, our speed rose to 31 m.p.h., with 35 and 40 per cent. admission, the engine blowing off with the injector on. Starting from Brive, with nine coaches or 341 tons, we accelerated to 24.8 m.p.h. before a P.W. slow and after St.-Denis-près-Martel rose to 27.9 m.p.h., while from Capdenac, with seventeen coaches, or 400 tons, climbed steadily at 24.8 m.p.h. On the up journey from Villefranche de Rouergue, with 340 tons, we accelerated to 34.7 m.p.h. up the bank. This shows the power of the engines, but steel fireboxes do not appear to give the same satisfaction as copper ones.

After the Armistice the French Government, to give work to the locomotive builders, ordered a considerable number of 4–6–2 compound superheater express engines, similar to those in use on the Etat Railways, and they have been allotted to the P.O., Est and Alsace-Lorraine railway companies in varying numbers.

Last autumn they began service between Paris and Bordeaux, and on two occasions on the Sud Express we had trains of seven and eight coaches, weighing 280 and 313 tons respectively. The speed of these engines is limited between Bordeaux-St.-Jean and the Raccord Direct before Lormont, to 18.6 m.p.h., owing to their weights. In these two runs we passed Lormont and La Gorp at 54.6 and 59 m.p.h., reached Libourne after the P.W. stop and slow for the bridge at Arveyres with intermediate maxima of 62.1 and 63.3 m.p.h., and touched 65.2 and 59 m.p.h. thence to Coutras. After Chalan an intermediate speed of 62.1 was attained on two occasions, and between Charmant and Angoulême 68.3 m.p.h. was reached in each case. On the first run the engine steamed so well that the dampers were several times shut to prevent excessive loss of steam by the safety valves, and the low-pressure cylinder pressures varied between 22 lb. and 37 lb. per square inch. On the second run the admission was 50 and 70 per cent. in the high and low-pressure cylinders respectively, with 180 lb. pressure in the high-pressure and 30 lb. to 37 lb. in the low-pressure cylinder. The engines were remarkably steady.

Another engine of the same class took us from Angoulême. Its speed varied between a minimum of 44.7 m.p.h. at Ruffec and a sustained speed thence to Poitiers of 59 to 65 m.p.h., with no more than 12 lb. pressure in the low-pressure receiver. From Poitiers we passed Chatellerault in 21 min. 15 sec., Port-de-Piles in 34 min. 40 sec., Monts in 56 min. 45 sec., and stopped at St.-Pierre-des-Corps in 67 min. 45 sec. after a signal check near the stop. The run was made with only the small regulator. From St.-Pierre-des-Corps, 3646 passed Blois in 36 min. 30 sec. at a minimum speed of 50 m.p.h., and stopped at Les Aubrais in 76 min. 50 sec., and from there passed Etampes in 44 min. 15 sec., stopping at Austerlitz in 86 min., after another P.W. slow, arriving 1 min. early. With the heavier load the running was very similar, but the run on to Les Aubrais was spoilt by a long signal stop on the bank before Blois, but so smart was the start on the 1 in 200 that the speed had reached 48.4 m.p.h. at that station.

On the down run I had a trip with the same load of seven coaches or 279 tons, and as far as St. Pierre, in both runs, engines of the 3500 class, No. 3559 and 3580. On the first runs Juvisy was passed at 37 m.p.h., in spite of a long P.W. slow, with a previous maximum of 58.4 m.p.h.; between Brétigny and Etampes the speed rose to 70.4 m.p.h., and then, on the 1 in 125, signals reduced our speed to 25 m.p.h., but at the top our speed had risen to 43.5 m.p.h. We maintained after that 56 m.p.h., the signals dropping before us, and after two other signal slows, stopped at Les Aubrais after a cautious approach. Here we exceeded our stay by 3¼ minutes, on account of luggage, but we passed La Chapelle

at 60.8 m.p.h., Blois at the regular reduced speed, Chouzy at 68.4 m.p.h., and stopped at St. Pierre-des-Corps on time exactly. The admission was 50 and 70 per cent. respectively in the two cylinders, with pressures of 22 lb. to 30 lb. in the low pressure, and after Bretigny the variable exhaust was opened, as we were full of water and were blowing off. From Les Aubrais the low-pressure receiver pressure was only 15 lb.

On the second run the weather was bad with a gale and rain. Speeds up to 68.4 m.p.h. were attained on part of the journey. On this run the pressure in the low-pressure receiver was 12 lb. to 15 lb., except when climbing Etampes, when it was 30 lb. per square inch; the boiler pressure was easily maintained and there was never less than three-quarters of a gauge glass of water. In the first run from St. Pierre we had No. 3591, an American-built simple superheater 4–6–2, and took 70 min. to Poitiers, where she had to come off, as the packing of one of the boiler manholes was leaking badly, and as spare engine we had No. 4047, a 4–6–0 non-superheated compound. However, the driver tackled his train pluckily and passed Couhé-Vérac in 28 min. 15 sec., Ruffec in 50 min. 30 sec., and stopped at Angoulême in 82 min. 10 sec., a loss of only 3 min. 10 sec. in the running, in spite of rain and wind. From there a "Pacific" type Etat No. 3679, in spite of bad slipping, passed Charmant in 18 min. 5 sec., Montboyer in 32 min. at 71.8 m.p.h., Coutras in 54 min. 10 sec., in spite of a previous signal slow, Libourne in 64 min. 15 sec., Veyres, after the bridge stop and slow, in 73 min. 15 sec., Lormont in 86 min., speed having risen to 68.4 m.p.h., and stopped in Bordeaux St. Jean in 96 min. 20 sec. gross, after the regular stop and speed limit from the Raccord Direct. The pressure varied between 30 lb. and 37 lb. in the low-pressure receiver. The 79.5 miles from Angoulême to Lormont had not taken more than 78 min. net.

On the second trip No. 3589, leaving St. Pierre, passed Monts at a speed of 45 m.p.h. up the 1 in 200, and thence to Poitiers our speed varied between 52.8 and 62.1 m.p.h., with an absolute maximum of 68.4 m.p.h. near Villeperdue.

From Poitiers, Iteuil was passed in 11 min. 5 sec., Couhé-Vérac in 23 min. 55 sec., Ruffec in 43 min. 45 sec., Vars in 63 min. 40 sec., and we stopped at Angoulême after a long P.W. slow in 76 min. 45 sec. gross. The low-pressure pressure was 22 lb., with no great opening of the regulator, but a long admission in the high pressure, and our speed was steady between 59 and 63.3 m.p.h., in spite of a wild gale and rain. On to Bordeaux a "Pacific" type Etat had by regular running made up 6 min. to Libourne, passed a minute early and stopped after an easy finish in Bordeaux 99 min. 30 sec. from the start.

In July of the present year, on the new Barcelona-Paris *rapide*, with seven coaches, or 316 tons, and No. 4523 from Montauban, we passed Caussade in 21 min. and stopped in Cahors in 57 min. 30 sec., including a relaying slow to 10 m.p.h. up the 1 in 100, after which slow we touched 40.3 m.p.h. before the top, with 56.9 lb. per square inch pressure in the low-pressure receiver, leaving a net time of 54 min. From Cahors we passed Thédirac in 22 min. 25 sec., Gourdon in 38 min. 50 sec., with an intermediate dead slow for a bridge, Souillac with another P.W. dead slow in 59 min. 20 sec., Gignac in 76 min. and, not dropping below 37.9 m.p.h., we stopped in Brive in 91 min. 40 sec. gross, or not more than 85 min. net, having made up 18 min. from Montauban. From Brive No. 4570 with the same load and in spite of a nasty mist, making the rails very slippery, ran to Limoges in 89 min. net, making up 11 min. Our load, increased at Limoges by the Luchon through carriages, was made up by a dining car to eleven coaches, equal to 484 tons, and engine 4577. From there we passed Issoudun in 21 min. 20 sec., at 48 m.p.h., the speed limit, and after a P.W. slow stopped at Vierzon in 48 min. 10 sec., or 45 min. net—a fine performance. There 3536 came on and took us easily on to Paris.

On the down run with the same train with eleven coaches, or 482 tons, very full, No. 3548 passed Juvisy after a maximum speed of 52.8 m.p.h., and stopped in Les Aubrais 30 sec. under booked time, the low pressure varying between 24 lb. and 28 lb. per square inch.

From there Vierzon was reached 3 min. early. There 4582 came on and took us to Limoges, where our load was reduced to ten coaches = 442 tons. Argenton was passed in 23 min. 45 sec.—smart work—Eguzon in 48 min. 35 sec., Forge-Vieille, dead slow to 10 m.p.h., in 63 min. 35 sec., Saint-Sulpice in 94 min. 30 sec., and with a signal slow outside Limoges stopped there in 121 min., 3 min. early. Here the Luchon coaches were cut off and the load was reduced to seven coaches, or 307 tons, and No. 4529 took us down to Brive, with absolute ease, arriving early. Thence No. 4543 took us to Montauban, the climb out of Brive to Gignac, up 1 in 100, taking only 23 min., with a final minimum of 38 m.p.h., and Souillac was passed in 36 min. 10 sec. This is my best climb by far since the war. The climb out of Cahors was smartly tackled and Montauban was reached on time.

All of these engines were fitted with exhaust injectors and from Paris to Les Aubrais they were on continuously, excepting for the slow at Etampes. The water level in the boiler was steady and the steam production excellent. These are fine runs for engines which had all been working for some time before the war.

On the Midi I have had numerous fine runs. In August, 1923, on the Foul Romeu *rapide*, with a light load of six coaches, or 222 tons, and No. 3117, speed within 2 kiloms. of the start up 1 in 200 from Toulouse reached 43.4 m.p.h. with 40 per cent. admission and 150 lb. steam in the valve chest, the first 8 miles being covered in 11 min. 40 sec. A P.W. slow here intervened, but at Villefranche, on the rising gradients, our speed reached 59 m.p.h. At Castelnaudary we had a signal slow and stop, but from there to Carcassonne only took 24 min. 5 sec., or a net time of 61 min. 45 sec. from Toulouse, our gross time being 2 min. 45 sec. under that booked, with a maximum authorised speed of 62.1 m.p.h. From there to Narbonne took 37 min. 20 sec., with maximum speeds of 67 and 65.8 m.p.h. and a pressure of 120 lb. per square inch in the valve chest.

On the same train in the winter of 1923, a bitter day of frost and north-west wind, with seven coaches = 214 tons, heated, No. 3103 from a signal stop before Villefranche maintained a speed of 59 m.p.h. up the final 1 in 200 to the water shed at Segala, and on the same day with the up train at night 3112 from Narbonne passed Marcorignan at 49.7 m.p.h., Moux at a minimum of 48 m.p.h., and stopped in Carcassonne after having twice touched 55 m.p.h., and being eased, as we were early. Castelnaudary was passed at 28 m.p.h., and on the way to Villefranche speed rose to 47 m.p.h. before the summit. In no case did the pressure exceed 120 lb. per square inch in the valve chest, and Toulouse was reached in 75 min. 15 sec. after a P.W. slow, or 71 min. net. With the same engine on the night *rapide* to Bordeaux from Marseilles, leaving Toulouse with eleven coaches, or 338 tons, heated, Montbartier was climbed at 52 m.p.h., Lavilledieu at 45 m.p.h., and Agen was reached punctually.

An up run from Bordeaux is remarkable. With a load of eleven coaches, 345 tons, steam heated, engine No. 3101, on account of the acceleration from the relaying slows and service slacks, the pressure in the valve chest varied between 156 lb. and 128 lb. per square inch with 38 per cent. admission. The first 3 minutes from Bordeaux have to be run at 18 m.p.h., but in 6 min. from the start our speed had reached 37 m.p.h., in 12 min. 54.6 m.p.h., and in 15 min. 59 m.p.h., and the distant signal of Langon, which was "on," was reached in 31 min. From that point in 3 min. our speed had reached 37 m.p.h., and in 6 min. 55.9 m.p.h. Marmande was passed in 64 min. 20 sec. gross at 18 m.p.h., the regulation speed; 6 min. after, we had reached 46.6 m.p.h. and were stopped at Tonneins in 80 min. 30 sec. gross owing to replacing the track and the subsoil; 3 min. after came another relaying slow, but within 9 min. we had reached 57.1 m.p.h., and 10 min. after that a signal stop, so that we took 122 min. to Agen, but our net time was only 94 min. This is one of the most noteworthy, as the regular fireman was sick and his substitute was making one of his first trips.

Perhaps my finest runs are the following two. From Cette and Narbonne, the first with 3101 and a load of sixteen coaches, 397 tons, only three of which were bogies and the rest mostly six-wheeled P.L.M. stock, out of Narbonne Marcorignan was passed in 11 min. 30 sec. at 43.4 m.p.h.; Lezignan at 40.3 m.p.h., our speed having risen previously to just 50 m.p.h.; Moux at the same speed; Capendu at 48.4 m.p.h.; and we stopped in Carcassonne in 53 min. 40 sec., having made up 3 min. From there Pezens was passed at 45 m.p.h., Bram at 50 m.p.h., after touching 52.8 m.p.h., and Castelnaudary was reached after another touch of 52.1 m.p.h. in 29 min. 45 sec., a gain of 5¼ min. The start was smart, 40 m.p.h. being attained in 6 min., and Segala was passed at 46.6 m.p.h., Villefranche was passed in 18 min. 50 sec., and Toulouse, after a long relaying slow, in 48 min. 35 sec. gross, or 43 min. 30 sec. net. The admission was 40 per cent., the boiler pressure was steady at 184 lb. per square inch, with from 142 lb. to 156 lb. per square inch in the valve chest. An exhaust steam injector which kept the water level constant was fitted, and the fireman kept it on continuously. For a train of this length the work was excellent; hard pulling, with coal of no wonderful quality, especially as regards size, it being chiefly slack with briquettes to replace the lumps. It is wonderful the confidence a full gauge glass and the certainty of keeping it full gives a driver who wants to regain minutes. As a French engineer once said, the real pressure gauge is in the gauge glass.

The other run was the Saturday before Easter, 1923. The engine was 3117 and the load from Cette thirteen coaches, 448 tons, with people standing in the corridors and a strong side wind from the north. Les Onglous was passed in 16 min. 35 sec. at 52.8 m.p.h. Time was lost at Beziers owing to the crowd of passengers. Colombiers was passed at 45 m.p.h., and before Narbonne our speed reached 62.1 m.p.h. There three more coaches were added, making a load of 495 tons, and Marcorignan was passed at 42.2 m.p.h., Lezignan at 38.5 m.p.h., Moux at 36 m.p.h. Carcassonne was reached in 55 min. 40 sec. from Bezieres, our speed having previously reached 50 m.p.h. From there we ran slowly owing to a tender being off the road, but from Castelnaudary we passed Ségala at 40 m.p.h. and reached 62.1 m.p.h. before passing Villefranche. We stopped in Toulouse in 45 min. 40 sec. The pressure in the valve chest was 128 lb. per square inch and 42 to 38 per cent. admission.

The Toulouse–Bayonne line, which was opened to electric working in June as far as Pau—and not Dax, as I stated in error—has given me before that date some interesting runs. The line follows the valley of the Garonne as far as Montréjeau, Gourdan-Polignan, with gradients rising practically all the way at from 1 in 333 to 1 in 150.

From there it climbs to Lannemezan, with gradients of 1 in 60, and after following the table land falls from Capvern to Tournay at 1 in 33, with climbs of 1 in 60 to Tarbes. From there it mounts to just before Lourdes, finishing at 1 in 70, and falls sharply to Nay at 1 in 60 and 1 in 66, following the valley down to Bayonne.

In 1923, No. 3507, with a load of sixteen coaches, 330 tons, from Toulouse, passed Portet-St.-Simon, 7.4 miles, in 11 min. 53 sec. at 47 m.p.h., and stopped at Muret, 13.6 miles in 19 min. 30 sec. Starting again, Carbonne, 12.4 miles, was passed in 18 min. 55 sec., speed being steady at 47 m.p.h., Cazères, 21.1 miles, in 30 min. 55 sec., at 40 m.p.h., and we stopped at Boussens, 27.3 miles, in 39 min. 40 sec., speed having reached 50 m.p.h. Starting again, we passed St. Martory, 3.7 miles, in 5 min., and stopped at St.-Gaudens, 15.5 miles, in 24 min. 10 sec., our speed up the 1 in 150 not going below 38.5 m.p.h. From there the line falls to the Garonne Bridge, which was passed at 40 m.p.h., and we stopped at Montréjeau, 8 miles, in 13 min., our speed up the 1 in 150 never dropping below 42.2 m.p.h. The admission was generally 38 per cent., and half to three-quarter tube of water. From Montréjeau our engines were 3527 and 4507, a 4–8–0 tank, the load thirteen coaches, 270 tons, and we took 19 min. 30 sec. up to Lannemezan, 10½ miles, our speed varying between 27.9 and 36 m.p.h. at the top, with a vacuum in the smoke-box of the 3500 of 5½in. On the descent of the gradient a system, known as the "contre-vapeur." perfected by Monsieur Herdner, the late Ingénieur en Chef Matériel et Traction, is employed. Steam and water are admitted into the cylinders from the boiler by two separate pipes until a slight spray from the exhaust is seen. The engine is then put into reverse, and the regulator opened. The speed is controlled by the position of the reverse lever, and no ill effects are noticed from the injection of water and steam washing off the oil. The water is vaporised by the compression. This arrangement is so satisfactory that no use is made of the air brake on the descent, and the injection of steam and water prevents any drawing in of hot gases and cinders through the exhaust pipe, as well as undue heating of the packing and cylinders. The maximum load a No. 3500 will take down alone is 130 tons and a No. 4100 2–8–0 American-built goods engine 150 tons. On passenger trains and on this exceptional gradient no overload is allowed, either up or down, and the maximum speed for passenger trains is 31 m.p.h. In cases of necessity for any reason or another, stops can, in ordinary circumstances, be made very rapidly with this method.

From Tarbes the line was worked electrically, and with a load of fifteen coaches, 318 tons, electric engine E 4501 passed Adé, 10½ miles, on a rising gradient in 17 min. 5 sec., the speed at the summit of the 1 in 70 being 38.5 m.p.h., and stopped at Lourdes, 12.4 miles, in 21 min. 30 sec., on time. Pau was reached punctually, and from there with the same load, 3717, a German 4–6–0 class P 8, took us down to Bayonne, the best run being from Peyrehorade to passing Lahonce, 15.5 miles, in 20 min. 55 sec., Bayonne being reached to time.

Perhaps my best performance was to climb from Montréjeau to Lannemezan, with a No. 3500 and a load of thirteen coaches = 278 tons, unaided, in exactly 31 min. on a wild night of rain, wind, thunder and lightning, with a very full train.

I think these runs, all made without any sort of preparation, show the every-day work of the Midi to be excellent; for almost every important station is at the foot of a bank each way, making the starting of heavy trains very laborious and difficult. This company shows an example of how passengers like speed. Bordeaux and Marseilles have three express trains a night; the first two, starting at 5.20 p.m. and 7.36 p.m., are packed; the third, starting at 7.57 p.m., is slower, and is practically empty, being made up largely of fish vans and empty coaches.

For goods trains the engines are big 2–8–0 American Consolidation taken over from the American Expeditionary Force, 0–8–0 German engines class G 8, and for parcels and goods traffic some 2–8–0 American engines with wagon top boilers. These are also used for the large pilgrim traffic to and from Lourdes, and on that service do some exceedingly good work. The goods trains load up to over sixty wagons, or 1000 tons, and are booked at between 18½ and 25 m.p.h. average for the through ones.

I am unable to speak of the electrification from personal experience, besides it is too new and recently put into service; but on the exceptional gradients from Nay to Montréjeau it is most satisfactory, and I have climbed the Capvern bank of 7.4 miles in 17 min., and I understand the new passenger Automotrice for high-speed running has climbed the 1 in 60 before Lourdes from Nay, with 250 tons, at a minimum of 52.8 m.p.h., which is encouraging for

the future. In any case, the trains are all well filled on the Bayonne line, including the new ones.

One of the chief difficulties of the Midi lies in the coal, most of which is imported by sea as "run of the mine." But by the time it is on the tender, the biggest lumps are often no bigger than one's fist, and the rest is slack, while some of the briquettes clinker badly. Were the firemen less well trained the steam production would be bound to suffer from the use of such uncongenial elements, and it says much for their skill that the pressure is generally at blowing-off point, in spite of working the engines so hard with fires that are not always as thick as they would like. The quality of the fuel used is such as to make a big grate area necessary, far bigger than would be necessary in England.

The relaying of the permanent way is proceeding fast, rails of 72ft. being standard, and the ballast is being replaced by crushed stone. This causes the endless P.W. slows, but when they are finished will leave a very good road bed. The coaching stock is now, on most of the *rapides*, mounted on bogies, while the four-wheeled coaches are employed on the less important trains.

The upkeep of the engines is good, and those of the Toulouse depôt, which I know best, are well cleaned and cared for.

The Design of Modern Glass-melting Furnaces.

A MEETING of the Society of Glass Technology was held in the University, Birmingham, on Wednesday, January 21st; for the purpose of discussing "The Design of Modern Glass-melting Furnaces." The subject was introduced by two papers, the first of which was:—"Some Recent Developments in Furnaces and Gas Producers for Glass Works," by Mr. J. S. Atkinson. The first part of this paper gave information based on more extended experience of the "Stein" recuperative pot furnace. A new design of "Unit" pot furnace was also explained, each unit or section containing two pots. Each section was independently controlled, having its own set of recuperators and gas and air valves, and also a separate chimney damper. One or two sections could be laid down in the first instance and other sections could be added as required. Turning to tank furnaces, the author described a design recently installed by Mr. T. C. Moorshead at the Charlton Works of United Glass Bottle Manufacturers, Limited. The melting tank was, he explained, shaped somewhat like a torpedo, and hence the name "Torpedo" tank. The merits of this furnace were stated to be:—(1) By eliminating the corners which the ordinary rectangular furnace had, a more rapid and uniform circulation of the glass was obtained; (2) the construction of the bridge, flared out as it was from the centre of the furnace, made it possible to ventilate or cool the side wall and bridge blocks much more efficiently; (3) the effective melting area was not reduced, but the volume of glass in the tank was reduced, giving higher melting efficiency.

Dealing next with continuous lehrs, Mr. Atkinson described a new design in which very radical changes had been made in the design of the conveyor belt and operating mechanism. The advantages claimed were:—(1) The high repair cost of the conveyor belts was practically eliminated; (2) stoppages necessitated by repairs to belt and the consequential loss of output were eliminated; (3) alternating current was as suitable as continuous current for the operation of the motor. The first cost of the installation of this new design was about the same as that of a lehr fitted with the Stephens Adamson type of belt.

Referring to gas producers, a description was given of an automatic ash remover which assisted the Chapman agitator working on the top of the fuel bed to maintain a homogeneous fuel bed. A high rate of gasification and a very rich quality of gas resulted. In addition, there were no heavy moving parts, and the ashes were removed continuously. The operation was very simple, and one man could operate from four to six producers.

The second paper was:—"Some Recent Developments in Furnaces and Gas Producers for Glass Works," by Mr. Th. Teisen, B.Sc. The author observed that it would be well if glass works would more clearly define their needs and the ideal main lines to be worked on—whether output was to be the deciding factor, or thermal efficiency, life, and so on. In any case the order in which these factors had to be placed must first of all be clearly defined, as that would decide the features of the design.

It had to be borne in mind that the use of automatic machinery had called for an increased output which, so long as it was not overdone, would raise the thermal efficiency. Following a discussion of the advantages and defects of the cross flame regenerative glass tank furnace, a comparison of it was made with the open-hearth steel furnace. The author expressed the opinion that in the case of small and medium sized tanks a high thermal efficiency might be more easily attained by the use of the recuperative type of furnace, in which the width could be relatively small, and the length could be made correspondingly longer, the flame passing towards the working end.

The author exhibited lantern slides showing a proposal for an accessible bridge, which was obtained by giving the tank a wasp shape. Burners might be arranged at the end, and draw-offs on either side of this wasp-shaped bridge. In conclusion, Mr. Teisen proposed the trial of an all-steel bridge cooled by water—the molten glass could be made to freeze round it and form a glass bridge. Although there might be some difficulties with the heating up before the glass was founded, he considered that this could be overcome by increasing the amount of cooling water, or it could be protected in other ways. The actual temperature, however, would hardly exceed that of the fire tube in a Cornish boiler.

The Bon Accord Irrigation—Transvaal.

THE Bon Accord irrigation system is situated on the Aapies River, about 9 miles north of Pretoria, at an altitude of 4000ft. It is described, with useful illustrations, in an article by Mr. E. H. Hughes, Assoc. M. Inst. C.E., appearing in the December issue of the *Magazine* of the South African Irrigation Department. As in other articles which have been published in that excellent quarterly, so in this one the information given is precise and to the point, and the descriptions of conditions and methods are of great interest.

The catchment, which includes the town of Pretoria, is 121 square miles in area, with an average annual rainfall of 28in. Of this total, about three-quarters usually falls in the rainy season, November to February inclusive, corresponding therefore, more or less, to a monsoon in India. The storage capacity of the reservoir above the outlet is 400 million cubic feet, corresponding to the run-off from 102 square miles of "bad" catchment during a monsoon of 21in. in Nagpur, by Binnie's tables, which may be regarded as a basis for comparisons. The estimate of the yield may be considered conservative as a calculation, or liberal with respect to areas downstream. In any case the comparison is a close one, as 20 square miles of the catchment is to be reserved for the municipality, and a dam is to be built on a spruit to the west of the town. The basis of the estimate of the area irrigable was 30in. of water depth on the land, reckoned at the dam, or 20in. depth delivered at the field boundaries, or water for 1300 morgen—2750 acres. This will not exhaust the capacity of the reservoir, and after a good rainy season some 530 acres will be added to the area irrigated. The reservoir has a storage capacity of nearly 415 million cubic feet, of which some 400 millions are above the outlet. The area at full supply level is 614 acres.

The calculation of flood discharge is notable for the large absorption capacity expected of the reservoir, an estimated flood of 22,000 cusecs being expected to yield a weir discharge of only 8000 cusecs. Owing to the nature of the catchment, a portion of which has a larger run-off than the remainder, the peak of the run-off curve in floods is expected to be sharp, while the area of the reservoir is fairly large in proportion to that of the catchment. For the rest it is, of course, a matter of the regulation of the water level during the rainy season. A very high absorption value may be assigned to a reservoir if there are certain to be considerable falls of rain at the tail end of the season and after all danger of further large floods has passed. The estimated maximum discharge of 22,000 cusecs corresponds to coefficients of about 640 and 900 with the Dickens and Ryves formulas respectively. The length of the spillway is 270ft.

The crest length of the earthen dam is 3476ft., and its maximum height above the river bed 58ft., with 8ft. freeboard above the spillway sill. The top width is 12ft., the upstream slopes 1 in 1½ for about the top quarter and 1 in 3 for the remainder; the downstream slope 1 in 2. The volume of earthwork is 407,000 cubic yards, and the area of the drystone pitching of the upstream slope is 34,640 square yards, the downstream slope being planted with grass. The outlet is 38ft. below the crest. The site of the dam presented some interesting features, the rock which forms the adjacent kopjes cropping out in knobs, of which advantage was taken in building the dam. This rock, "Norite," was found to be decomposed unequally, and exhibited notable variations in the degree of decomposition, being soft to a depth of 20ft. in several places. The trench was taken down to a maximum depth of 28ft., the depth being limited because blasting tended to shatter the adjacent rock. Percolation through the rock, which is fissured athwart the dam, was expected and has occurred, the seepage being collected and drained away. The work having been taken over from a contractor in September, 1922, construction during the ensuing rainy season was confined to the flanks, and by April the desired output of 25,000 cubic yards per month had been reached and passed, the average from April to September being over 31,000 cubic yards per month. During the building of the dam water was supplied by pipes laid along it, so that the earth could be kept sprayed. The employment of petty contractors who carted earth, supplementing the work of the locomotives, proved satisfactory. By October the dam was safe against any probable flood; the work was completed by April, 1924, and irrigation water was being supplied in August.

The outlet culvert discharges into three stilling and distribution chambers, two of which supply the right and left bank canals, while the third passes the normal flow of the stream, the compensation water allotted under the judgment of a Water Court. The right bank canal, 0.74 miles long, has a capacity diminishing from 16.10 cusecs to 4.56 cusecs, the velocity ranging from 1.17ft. per second to 0.94ft. per second. The left bank canal, 11.3 miles long, has a capacity diminishing from 18.74 to 3.5 cusecs, and velocities 1.20 to 0.75ft. per second. Irrigation will be carried out all the year round, but chiefly in the spring months before the first rains. The chief crops will be vegetables and lucerne.

SIXTY YEARS AGO.

IN our issue of February 3rd, 1865, we recorded the death of Mr. T. B. Neilson, F.R.S., the inventor of the hot-blast system of iron smelting. Mr. Neilson was born near Glasgow in 1792. "In youth his education was not neglected," we wrote, "and he had the good fortune to find employment with several ironmasters of skill and talent." His attention was directed apparently by an accident to the field in which he won renown. After experimenting, he secured a patent for the hot blast, in conjunction with three fellow-citizens, Messrs. Macintosh, Dunlop and Wilson. The process was introduced in 1828, at which date the blast-furnaces of Scotland were producing only about 30,000 tons per year, the average price being some £7 per ton. In 1864, we noted, the output exceeded 1,160,000 tons, and the price had fallen to an average of about £2 17s. 3d. Much of this increased supply and reduction of cost was, we suggested, to be ascribed to Mr. Neilson's credit. At first he demanded a royalty of only 1s. a ton for the use of his invention, but years of litigation were required before the validity of the patent was satisfactorily decided. Thereafter Mr. Neilson and his supporters won the reward their labours and persistency merited. It may be added that Mr. Neilson's son founded the engineering business of Neilson and Co. in Hydepark-street, Glasgow, which subsequently became Neilson, Reid and Co., whose Hydepark Works at Springburn now form one of the units of the North British Locomotive Company, Limited. . . . In the same issue reference was made to a curious discovery reported by M. Du Moncel to the Paris Academy. It seems that M. Carlier, an electrician of Paris, had been investigating the construction of electro-magnets with the object of determining whether the insulation—silk, cotton, rubber or varnish—invariably applied to the wire of the coils was really necessary. It was found that not only was the insulation unnecessary, but that the magnet with uninsulated wire exerted a considerably stronger force than it did when wound with insulated wire. According to M. Du Moncel, a bar of iron, 4½ cm. in length and 7 mm. in diameter, wound with a single spiral of wire 0.277 mm. in diameter, and energised by means of two small Bunsen elements, supported a weight of 3.9 kilos. (? grammes) when the wire was not insulated, and only 2.4 kilos. when the wire was covered. A larger magnet, with twelve layers of wire, supported 940 grammes (*sic*) with uncovered wire and 540 grammes with covered wire. The effects of attraction at a distance were, it is recorded, even more favourable to the uncovered wire. An explanation of the phenomenon was attempted, but the terms employed—such as electric flux, superposed currents, and derivations—are too uncertain in their meaning to invite us to interpret the explanation in modern phraseology.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

CUTTING TOOL RESEARCH.

SIR,—I notice that in your leading article of January 30th on the reports from the National Physical Laboratory on the action of cutting tools, which were discussed at the Institution of Mechanical Engineers on January 23rd, there is some tendency to criticise the work on the ground of its not being of a sufficiently practical nature to be of value to engineers.

I venture to think that this attitude is due to imperfect acquaintance with the history of the Cutting Tools Research Committee of the Institution.

This Committee was formed in 1919, and a research programme on practical lines, involving the formation of some six panels, each of which would deal with a particular method of cutting, was drawn up by a sub-committee appointed for the purpose, and approved by the main Committee in 1920. Later in that year, however, a memorandum by Mr. William Taylor, member of Council, was submitted to the Committee, strongly urging the importance of a preliminary study of the "fundamentals" of cutting action, or, in other words, proposing that before entering upon a research on the admittedly complicated actions which constitute metal cutting under modern works conditions, some addition to our knowledge should be obtained as to how a tool cuts and why a tool cuts. It will be clear that this proposal was of a somewhat revolutionary character for the Institution to adopt, since it involved changing the nature of the research from that of an *ad hoc* investigation on cutting tools to the study of the fundamental action of cutting, which might be regarded by some as the highest form of engineering research, and by others as a branch of mechanical philosophy with which the mechanical engineer was only remotely concerned. The result of the memorandum was that the main Committee approved Mr. Taylor's proposal, and set up a Sub-committee on Fundamentals, and the papers discussed before the Institution on January 23rd described work undertaken for this Sub-committee.

Without wishing to enter upon a discussion of the wisdom of the step taken, I should be glad if you will allow me to bring the above facts to the attention of your readers, as I think that an appreciation of them will go far to meet the criticisms on the reports which have been made.

T. E. STANTON.

The National Physical Laboratory,
Engineering Department,
Teddington, Middlesex, February 2nd.

[The intention of the article to which Dr. Stanton refers was to meet probable criticism in advance, and as the last paragraph indicates, to urge practical people to have patience whilst the philosophy of cutting was being studied by the Sub-committee on Fundamentals.—ED. THE E.]

THE BRITISH STEAM LOCOMOTIVE FROM 1825 TO 1924

SIR,—Referring to Stephenson's locomotives for France, supplied to the orders of M. Séguin, which were briefly mentioned by me in your issue of January 9th, page 34, my attention has been drawn by Mr. Warren to an error in footnote 4. The illustration on page 136 of Mr. Warren's book, "A Century of Locomotive Building," represents a locomotive subsequently built by Séguin himself, and not the earlier ones by Stephenson, though the latter had a similar cylinder arrangement. Séguin's engine was also illustrated in Mr. Forward's articles in THE ENGINEER of December 14th and 21st, 1923.

I regret that I inadvertently omitted to state that the illustration—Fig. 4, page 34—showing the Lancashire Witch, was taken from Mr. Warren's book, "A Century of Locomotive Building," by kind permission of R. Stephenson and Co., Limited.

E. L. AHRONS.

Nottingham, January 31st.

INSTITUTION OF NAVAL ARCHITECTS.—GOLD MEDAL AND PREMIUM.—The Council of the Institution of Naval Architects has awarded the Gold Medal for 1924 to Eng. Commander R. Beeman, C.M.G., R.N., for his paper "Further Experimental Work on Diesel Engines," and the Premium to Professor K. Suyehiro, D. Eng., for his paper "The Drift of Ships Caused by Rolling Among Waves." These awards will be presented on April 1st next at the opening of the annual general meetings, which will be held at the Royal Society of Arts, John-street, W.C. 2.

Main Line Railway Electrification.

By Sir PHILIP DAWSON, M. Inst. C.E., &c., Consulting Engineer, and
S. PARKER SMITH, D.Sc., M.I.E.E., Professor of Electrical Engineering, Royal Technical College, Glasgow.

No. V.—SCANDINAVIA (*continued*).*

4 (A). SWEDISH STATE RAILWAYS: RIKSGRANSEN RAILWAY.

THIS line is situated in the north of Sweden, and lies completely within the Arctic Circle, with the exception of the Murjek–Lulea section. The climatic conditions are very severe. The original electrified part, Kiruna–Riksgränsen, was opened in 1915; it is 129 km. in length, single track and standard gauge. The line is used principally for iron ore haulage from the Lapland mines at Kiruna and Gällivare to the Swedish port at Svartön and the Norwegian port of Narvik, which latter, through the influence of the Gulf Stream, is always ice-free. The line has had an ever-increasing ore traffic, and before 1915 was loaded to its fullest capacity. Either

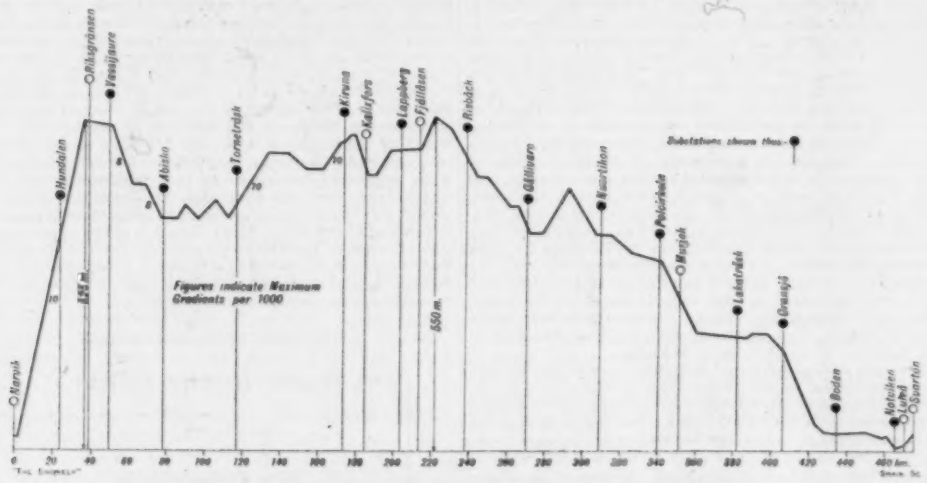


FIG. 2—PROFILE OF NARVIK - RIKSGRANSEN - SVARTON RAILWAY

expenditure was realised, and, moreover, the difficulties associated with the use of steam locomotives in the tunnels on the Abisko–Riksgränsen section (which with the snow galleries aggregate 7 km.) were avoided. The complete coast-to-coast line from Svartön and Lulea to Narvik is 476 km. in length, of which the last 42 km. are in Norway. Fig. 2 gives a profile of the line.

Power is supplied for the whole route from Porjus hydro-electric station, on the Lule River. A series of waterfalls occur on this river, with a potential capacity of 400,000 H.P. The Porjus fall was utilised for the power station. As no means of transport existed at the time of the inception of the work, a 55 km. standard gauge track was built from Gällivare to Porjus, connecting at the former place with the State Railway. The Lule Lake, from which the river flows, forms a large natural reservoir, and a simple dam 1500 m. long was needed to provide a head of about 52 m. The lake has a normal discharge of 40 m³ per sec., but will discharge 100 m³ per sec. for seven months of the year. The water is conducted by a tunnel to the penstocks, and then reaches the turbines through vertical pipes 3.5 m. in diameter and 50 m. deep. The generator room is below ground blasted out of the solid rock, while the transformers and switchgear are housed at ground level. In the generator room, space is available for 10 sets each of 10,000 kVA at 225 r.p.m. together with automatic regulators. At present six sets are installed: three generate single-phase current for traction; two generate three-phase current for the iron mines and general industrial uses; the sixth has as reserve a single and a three-phase generator on the same shaft. There is also a D.C. generator for excitation and power-house requirements, coupled to a 525 H.P turbine. This set receives water through a separate vertical shaft 0.35 m. in diameter.

The traction energy is generated at 4000 V., 15 cycles. Transformers with a 4000/40,000 V. ratio feed the long-distance transmission line at 80,000 V., the transformers being in parallel on the low-voltage side and in series on the high-voltage side. Oil switches are installed on the high-tension side only.

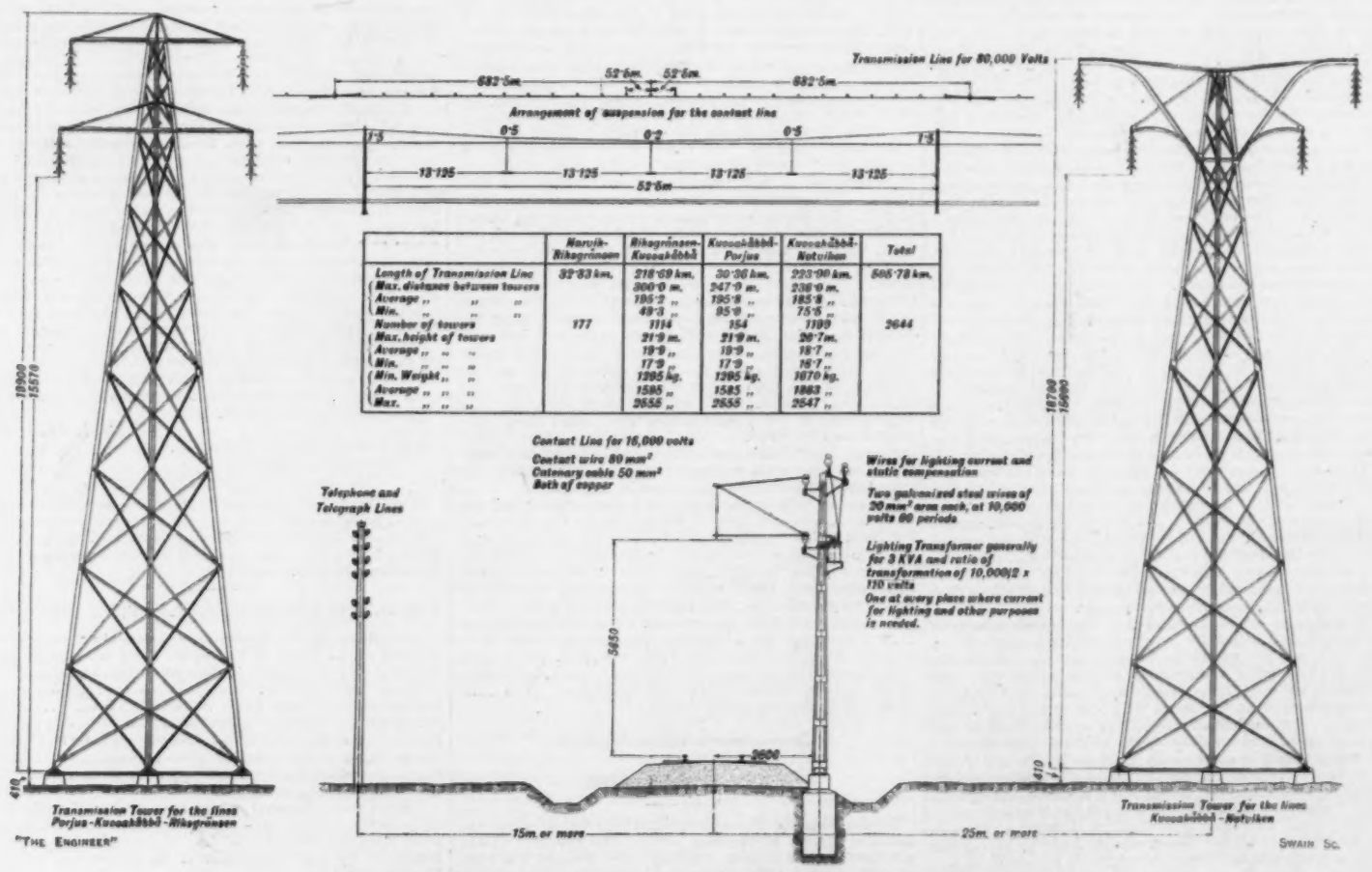
The transmission line is taken to 15 sub-stations, spaced on an average of 35 km., situated at:—Narvik, in Norway; Hundalen, in Norway; Vassijaure, near Riksgränsen; Abisko; Tornesträsk; Kiruna; Lappberg, between Kalixfors and Fjällasen; Risbäck; Gällivare; Nuortikon, between Gällivare and Murjek; Polcirkeln, near Murjek; Lakaträsk; Gransjö; Boden; and Notviken, near Lulea.

The positions of the sub-stations are indicated in Figs. 1 (*ante*) and 2.

At each sub-station two or three 80,000/16,000 V. step-down transformers are installed for feeding the overhead contact line, together with auxiliary circuits for the stations. The transformers are 1100 to 1500 kVA each, oil-cooled, and are so arranged that they can be easily sent by rail on a special car to the repair depôts at Kiruna and Notviken, if necessary.

The transmission line is in duplicate, and is carried on three or four-legged steel towers, 16.7 to 21.9 m. high. Four wires are thus necessary for the two circuits. The maximum sag is 10 m. and the minimum height above ground is 7 m. The span averages 49.3 m. with a maximum of 300 m. Four-legged anchoring masts are placed at intervals of 9 or 11 spans.

The overhead contact line is of a simple catenary pattern, the contact wire being supported from the catenary wire at the supports and at three intermediate points, the total span being 52.5 m. on straight open track. The contact wire is hung in independent sections of 1365 m. length, stretched at each end by counterweights. The arrangement of the trolley line and 80,000 volt transmission line for the Riksgränsen–Svartön line is shown in Fig. 3. On top of the trolley poles are two insulators, mounted as shown, each carrying one 6 mm. steel wire. These wires are used for transmitting 60-cycle single-phase current at 10,000 volts to all stations and other places along the road. The voltage is stepped down to 2 × 110 volts at such places by means of small


Transmission Line for 80,000 Volts
682·5m. 52·5m. 52·5m. 682·5m.
Arrangement of suspension for the contact line
1·5 0·5 0·2 0·5 1·5
13·125 13·125 13·125 13·125
52·5m.
Contact Line for 16,000 volts
Contact wire 80 mm²
Catenary cable 50 mm²
Both of copper
Telephone and Telegraph Lines
Wires for lighting current and static compensation
Two galvanized steel wires of 20 mm² area each, at 10,000 volts 60 periods
Lighting Transformer generally for 3 KVA and ratio of transformation of 10,000/2 x 110 volts
One at every place where current for lighting and other purposes is needed.
5450
2600
410
15m. or more
25m. or more
Transmission Tower for the line Porjus-Kvocakåbbå-Riksgränsen
Transmission Tower for the line Kvocakåbbå-Notviken
"THE ENGINEER"
SWAIN Sc.

	Narvik-Riksgränsen	Riksgränsen-Kvocakåbbå	Kvocakåbbå-Porjus	Kvocakåbbå-Notviken	Total
Length of Transmission Line	32·83 km.	218·69 km.	30·36 km.	223·90 km.	505·78 km.
Max. distance between towers		300·0 m.	247·9 m.	238·9 m.	
Average " " "		195·2 "	195·8 "	185·8 "	
Min. " " "		49·3 "	95·9 "	75·5 "	
Number of towers	177	1114	154	1199	2644
Max. height of towers		21·9 m.	21·9 m.	20·7 m.	
Average " " "		19·9 "	19·9 "	18·7 "	
Min. " " "		17·9 "	17·9 "	16·7 "	
Min. Weight " "		1295 kg.	1295 kg.	1070 kg.	
Average " " "		1585 "	1585 "	1883 "	
Max. " " "		2655 "	2655 "	2547 "	

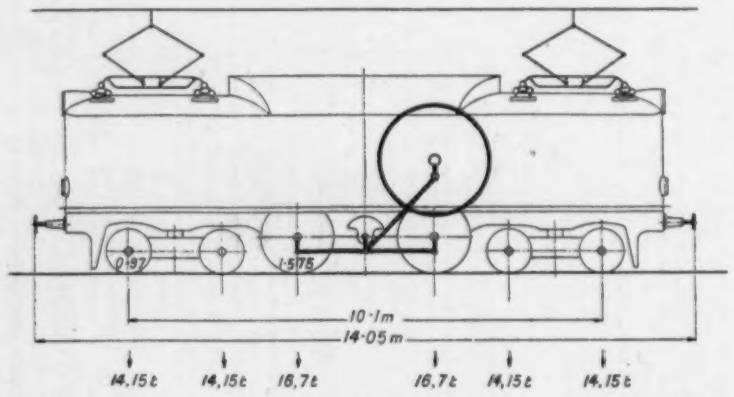
FIG. 3—TRANSMISSION AND CONTACT LINE CONSTRUCTION—RIKSGRANSEN RAILWAY

double tracking or electrification was the solution to the problem, and the latter was adopted for economic reasons. The result was an increase of train weight by 40 per cent., and of average train speed, including stops, at stations, of about 100 per cent., the maximum speed for ore trains being 60 km. per hour as before. A considerable saving in fuel, wear and tear, running costs and capital transformers—in general of 3 kVA capacity—mounted on the trolley-poles as shown in the drawing. In this way all buildings along the line are supplied with electric power for lighting and other purposes.

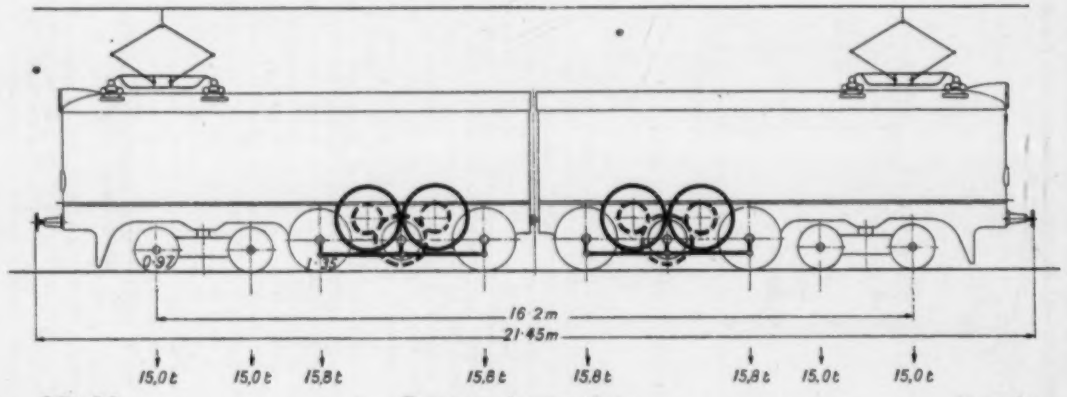
The rolling stock comprises 4 express, 1 passenger, 33 mineral, 12 freight and shunting locomotives, and 2 motor coaches. Diagrams showing the arrangement and drive of these are given on p. 157 and Fig. 4.

* No. IV. appeared January 23rd, 1925.

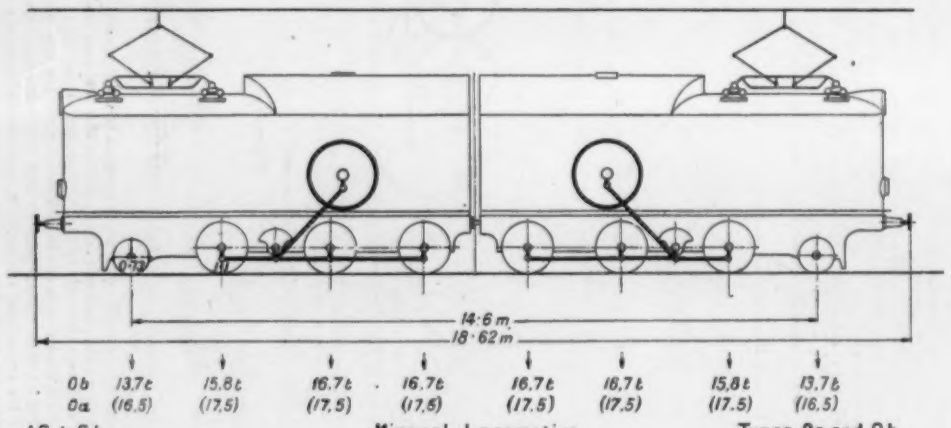
RIKSGRANSEN RAILWAY—ELECTRIC LOCOMOTIVES



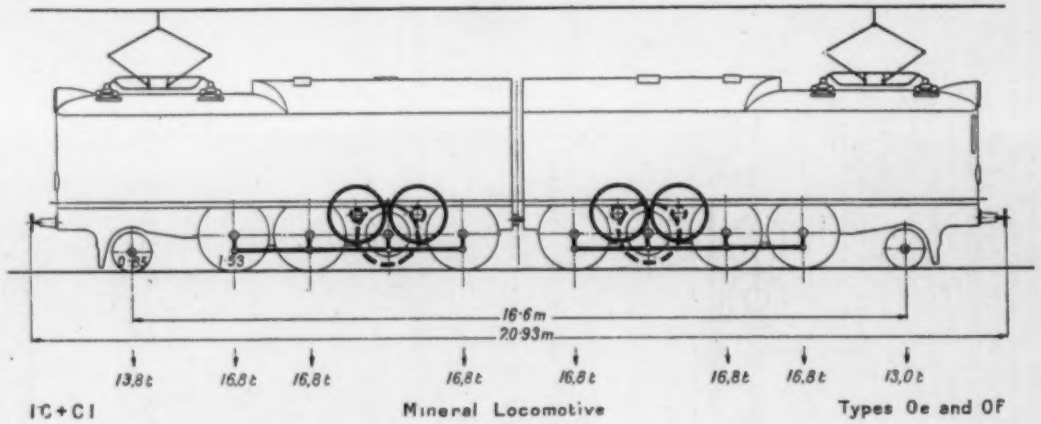
2 B 2 Express Locomotive Type Pa



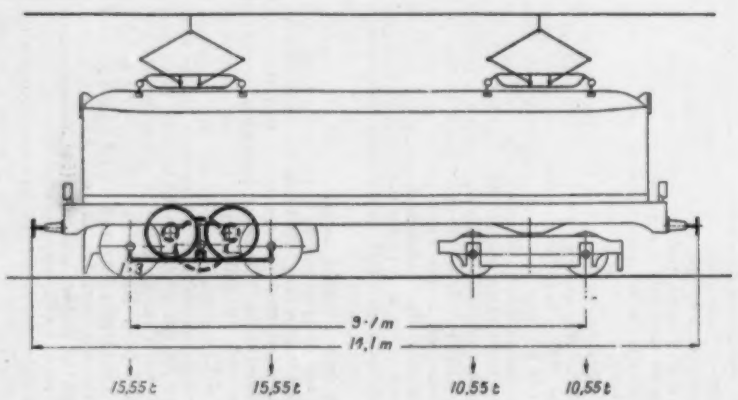
2 B+B2 Express Locomotives Type Pb



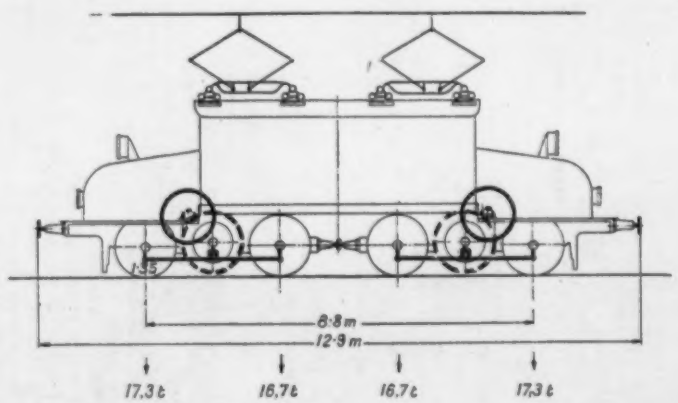
1C + C1 Mineral Locomotive Types 0a and 0b



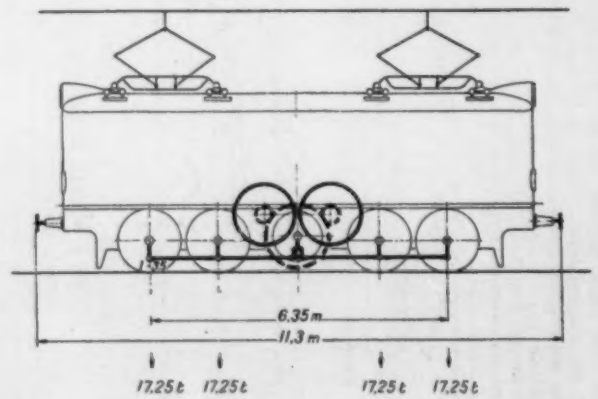
1C+C1 Mineral Locomotive Types 0e and 0f



B-2 Passenger Locomotive Type Z



B + B Freight Locomotive Type 0c



D Freight Locomotive Type 0d

"THE ENGINEER" SWAN SC.

The express locomotives have a 2 B 2 axle arrangement, with a single large motor, 900 H.P., 170 r.p.m., driving by connecting-rods without gears. The locomotives weigh 90 tons, and their maximum speed is 100 km. per hour. Only 35 tons of the weight is utilised for adhesion, and the tractive effort is 8 tons.

The passenger locomotive (B — 2) is carried on two bogies, one of which is equipped with two motors for driving by gear and connecting-rods. The machine is designed to haul a train of 120 tons at 75 km. per hour.

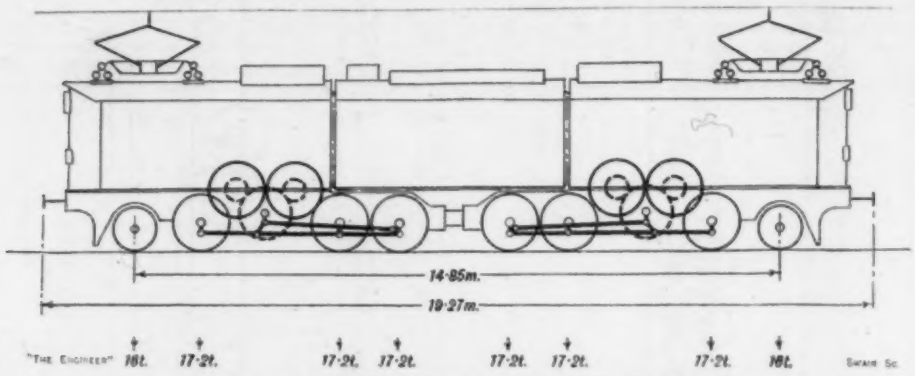


FIG. 4—MINERAL LOCOMOTIVE EQUIPPED FOR REGENERATIVE BRAKING

The most important locomotives are naturally those for mineral trains. Sixteen of these (the newer type) are made up of two similar units, close-coupled, forming a 1 C + C 1 combination, designed to haul a 2000-ton train up a 1 % gradient at 30–35 km. per hr. This demands an output of 2600 kW, taking 13 kg. per ton tractive resistance. One force-cooled twin-motor is used for each half locomotive, and comprises two armatures driving on to a single gear-wheel, from which coupling-rods connect the three driving axles. These locomotives were built jointly by the A.E.G., the S.S.W. and Motala Verkstad in Sweden.

The 17 earlier mineral locomotives are also of the 1 C + C 1 type, but are intended for hauling 1500-ton trains, and are of 2000 kW output. No gears are used in this case, the drive being direct from the motors to jack-shafts by oblique connecting-rods.

Two of the goods locomotives (B + B type) are very similar to those in use on the Prussian Railways, and were supplied by the A.E.G. for hauling 700-ton trains at a maximum speed of 60 km. per hour. In the frame of each bogie a neutralised series motor drives through bevel gears at each end to short coupling rods.

Two further locomotive types have been supplied by the A.S.E.A., namely, 10 D-type freight, and 2 express 2 B + B 2 locomotives. In each case the drive is by gear to a jack axle which in turn drives the main axles by coupling rods. The express locomotive has double the output (2250 H.P.) of the goods locomotive, and its maximum speed is 100 km. per hour. The motors in the two types are identical, being neutralised series machines of 550 H.P. at 1-hour rating. The number of controller steps is 20 for the express, and 11 for the goods locomotive. The motors are permanently connected in series groups of two.

Mineral trains consist either of 40 ore wagons, one van, and one locomotive of the newer type, the total loaded weight being 2000 tons; or of 30 wagons, a van, and a locomotive of the older type, the total weight loaded being 1530 tons. A speed of 30–35 km. per hour can be maintained up the maximum gradient (1 %).

In general the mineral trains run either from Kiruna to Narvik or from Gällivare to Lulea and Svartön. Some trains also run from Gällivare to Narvik and from Kiruna to Svartön. In general only 40-wagon trains are operated, for which pushing locomotives are used for the old 1 C + C 1 locomotives on the heavier gradients (for instance, from Gällivare south to Ripats).

It is intersting to note that the locomotives on the Riksgränsen–Narvik section in Norway ("Ofotenbanan") which presents a continuous down gradient to *loaded* trains, will be equipped for regenerative braking, and owing to the trend of the traffic it is expected to regain a certain percentage of the energy expended in hauling empty trains up the grade to Riksgränsen. The two mineral locomotives supplied by Brown, Boveri and Co.—last line in Table IV., page 99—will be among the most powerful of European single-phase locomotives yet built. The regenerative system employs a phase-shifter which displaces the exciting pressure by 90° from the line voltage. The motor armatures then furnish energy back to the main transformer, over the regulating tapping-switch, and so to the pantographs. An outline diagram of this locomotive is given in Fig. 5.

4. (B) SWEDISH STATE RAILWAYS: STOCKHOLM GOTHENBURG LINE.

This railway is a cross country line in the southern part of Sweden. (See profile in Fig. 5.) The transportation consists of passenger and freight trains. Single-phase current at 16⅔ cycles and 16,000 volts for the trolley line will be used for the electrification. The necessary electrical energy will be taken from the State-owned main three-phase transmission lines where these lines cross the railway at Södertälje, Sköldinge, Hallsberg, Moholm and Alingsas. (See Figs. 1 and 5.) At each of these places sub-stations will be erected containing motor-generators for changing the three-phase current to single-phase. The three-phase lines have potentials varying from 50,000 to 130,000 volts. This pressure will be transformed down to 6000 volts for the motor-generators in the sub-stations. The single-phase current will be generated at 3000 volts and stepped up by means of transformers to 16,000 volts.

In each of the sub-stations at Södertälje and Alingsas will be installed three motor-generators, and in each of the other sub-stations two such motor-generators. All these sets will be alike and will have an output on the single-phase side of 2400 kVA continuously and 4800 kVA maximum. Each sub-station will feed its own separate section of the trolley line. These sections will vary in length from 75 to 114 kilometres and will each be divided in two parts at the sub-stations.

The trolley line will be constructed, as indicated in Fig. 6, with an insulated copper cable for the return current; this return-feeder will be connected to the rails. Milking transformers will be connected in the trolley wire and the return feeder at points midway between the connections from the return cable to the rails. No bonding is in this case necessary for the rails, and the track can be maintained without danger to the platelayers. This is, of course, a feature of the utmost importance.

No feeder lines of any kind will be used, and the whole supply system for the railway electrification will therefore be only the five sub-stations and the trolley lines. It is therefore expected to complete the whole electrification by the end of 1925. For this electrification, fifty electric locomotives have been ordered. They will all be of the type 1 C 1, as shown in Fig. 7. Ten locomotives will be delivered geared for passenger service, and forty for freight service. The locomotives will, however, be built so that

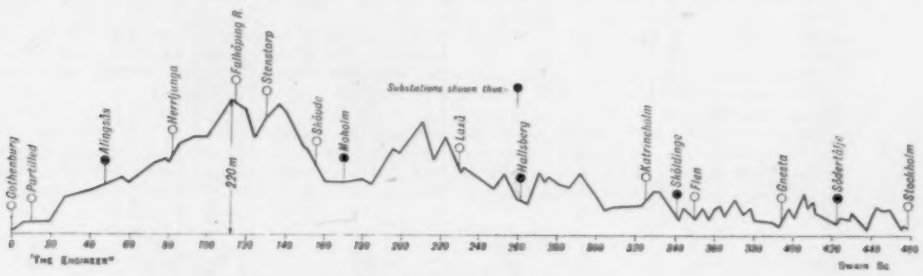


FIG. 5—PROFILE OF STOCKHOLM-GOTHENBURG RAILWAY

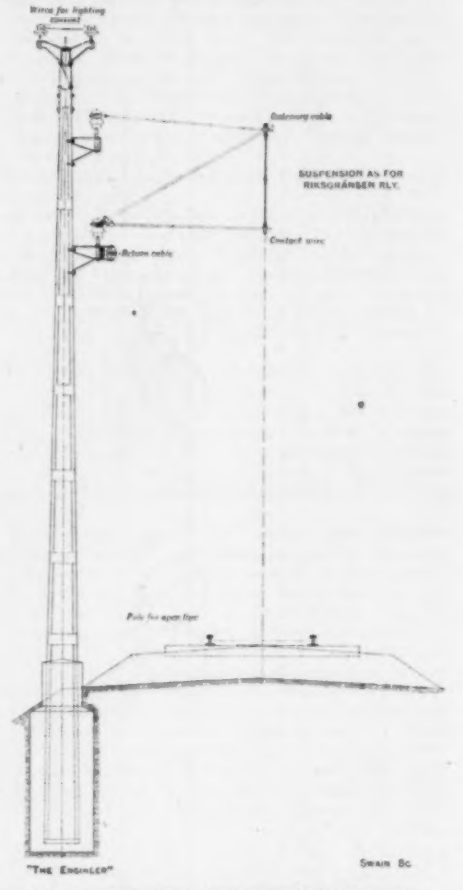


FIG. 6—CONTACT LINE CONSTRUCTION—STOCKHOLM-GOTHENBURG RAILWAY

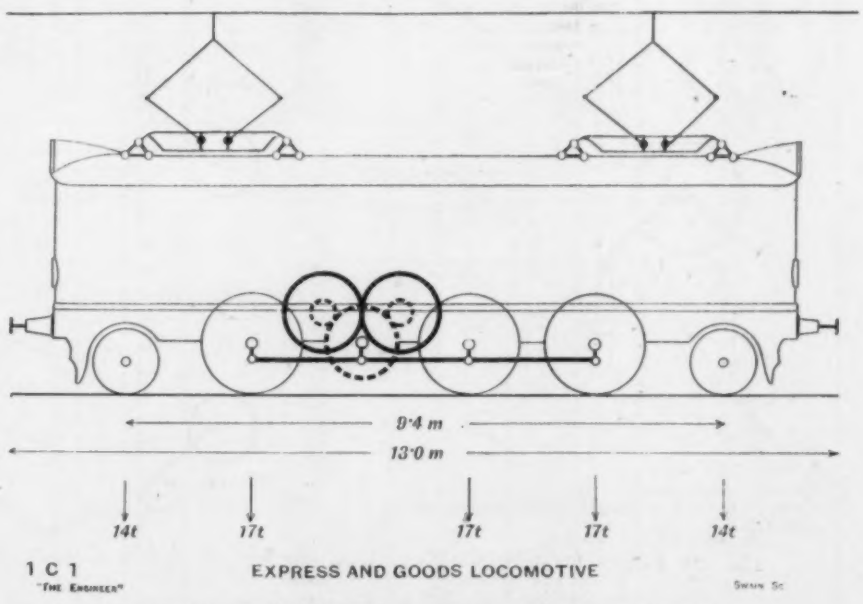


FIG. 7—ELECTRIC LOCOMOTIVE—STOCKHOLM-GOTHENBURG RAILWAY

the gears can be easily changed, if and when desirable.

In passenger service the locomotives will haul train weights up to 500 tons, with speeds up to 90 km. per hour, and as freight locomotives they will be able to haul up to 900 tons trailing, with speeds up to 70 km. per hour. The total weight per locomotive will be 79 tons, of which 51 tons will be on the drivers.

4 (c). NORWEGIAN STATE RAILWAYS: KRISTIANIA–DRAMMEN LINE.

The Kristiania–Drammen line, a part of the "Westbanan" (see Fig. 1 *ante*), is the first electrification of the Norwegian State Railways on a main-line scale, the Thamshavn–Lökken and Rjukan (Notodden–Tinnoset and Rjukan–Rollag) lines being of the nature of light railways. The line runs south-west from Kristiania to Sandviken (13 km.), Asker (23 km.), and Drammen (53 km). The first-mentioned part is double tracked, and has a heavy local traffic. The total train movement is now of the order of 200 million ton-km. per annum, but is expected to increase to 200 million ton-km. Gradients up to 1.4% and 1.66% for short distances are attained. The line sare now standard gauge.

Power is developed in a special hydro-electric station at Hakavik with enormous storage capacity. The water accumulates in two large lakes, and is led to the power-house by a 1.5 km. pressure tunnel and a 1 km. pipe line. The prime movers are three Pelton wheels, and the generators are each of 2700 kVA capacity continuously and 3750 kVA maximum. The head is fairly high—390 m. The station will work in parallel with one or more other hydro-electric stations when the traction requirements increase. The energy is transmitted to Asker, a distance of 50 km., by a 60,000 V. line, consisting of four conductors on single poles. At Asker the power is received at about 55,000 V. and transformed to 16,000 V. The frequency is 15. In order partly to compensate for line drop, the power station is over-compounded by about 20 per cent. The catenary-suspended contact line (Fig. 8) is carried on iron posts. In order to reduce interference with the heavy traffic on the communication circuits alongside the track "milking" transformers are installed every 1.5 km. They are provided with two windings on the double-track section, and with three windings on the single-track section (Sandviken–Drammen) for the contact wires, track and feeder line. (The latter runs along the single-track section only.) The transformers are so arranged that with 250 A in the contact line, full compensation is obtained. On short-circuit the uncompensated amp.km. will not exceed 600.

Fig. 9 shows the arrangements of the B — B and 1 B + B 1 locomotives for this line. The latter are for experimental purposes, and were equipped provisionally for goods traffic, with a maximum speed of 50 km. per hour. The two motors are each rated at 500 H.P. continuous, at 630 r.p.m. Later the gear ratio will be changed to enable the locomotives to be used for express work at a maximum speed of 90 km. per hour. The control is by sliding contact switch (thirteen steps), varying the transformer voltage on the secondary side from 100 to 620 V. The total weight of a locomotive is 77.5 tons.

The B — B locomotives are of the well-known double-bogie design, rated at 940 H.P. (one hour).

The railway electrification in Norway is now being continued with the Kristiania–Lillestrom section (22 km. double-track and partly three tracks) and the Drammen–Kongsberg line, 46 km. in length.

5. RESULTS OF ELECTRIFICATION.

(*a*) *General.*—It is possible to obtain results only from the Riksgränsen Railway at present, but the equipment of this line for electric haulage has been fully justified. The State is under an agreement to carry an increasing quantity of ore yearly. Thus, 1,660,000 tons were carried in 1908, and under the contract the load for 1918 was 3,850,000 tons. With steam haulage this would have been impossible on a single-line track, but electrification has solved the problem at a cost less than that of double-tracking. The maximum safe train length formerly consisted of twenty-eight ore wagons and one two-axle goods van; longer trains were found to strain the couplings. With electric haulage the train length was increased by 50 per cent., and the train speed by 40 per cent. on the level and more than 100 per cent. on the steepest grade. The annual saving is considerable.

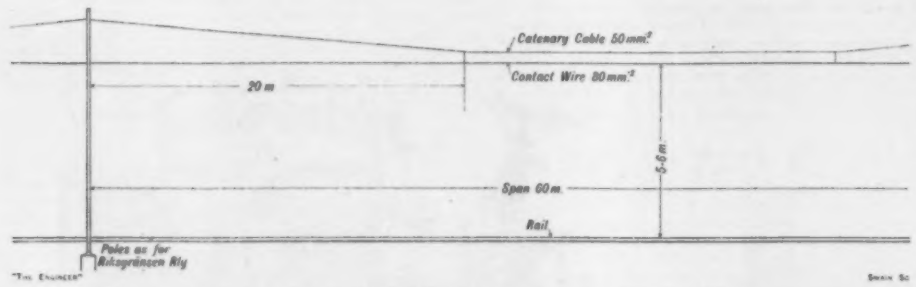


FIG. 8—CONTACT LINE CONSTRUCTION—KRISTIANIA-DRAMMEN RAILWAY

Between Abisko and Björkliden the line has a 1% gradient, which is met with in a tunnel 1.1 km. long. Formerly, steam engines had to develop full load on entering, with consequent foulness of the tunnel.

The Kristiania–Drammen line was altered from narrow to normal gauge, and electrified, simultaneously, to improve the traffic conditions. The results are expected to justify the expenditure.

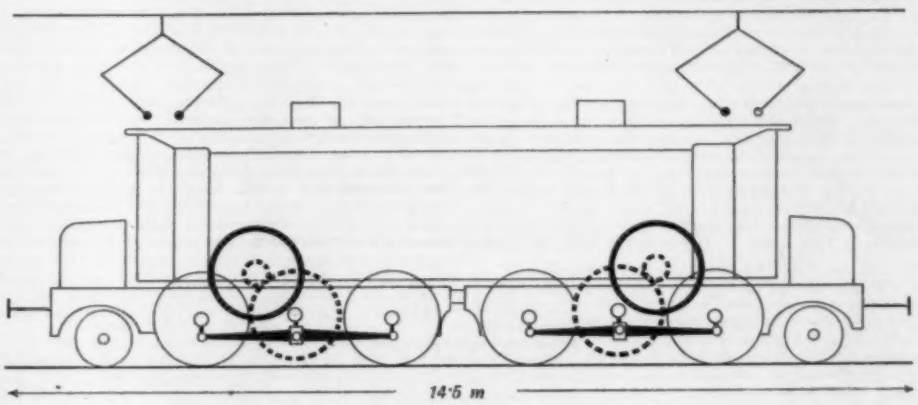
(*b*) *Interference with Communication Circuits.*—A comprehensive report on tests of interference made on the Riksgränsen Railway was published by the Swedish State Railways Administration in 1920. The section under test was that between Kiruna and Riksgränsen. The conclusions, as given in the report named, are summarised below:—

The apparatus now available works very satisfactorily, but at the same time can only be regarded as preliminary. The steps to be taken for the avoidance of interference due to pressures in the feeding and contact lines are:—The communication circuits must be removed at least 100 m. from the track or placed in cables. If this is not possible, the circuits may be placed at a minimum distance of 15 m. from the track, provided that a compensating line is used with the trolley wire and that the feeding line is frequently transposed.

It is more difficult to suppress disturbances due to the traction current. Two-pole contact wires might be used, giving complete compensation. On the other hand, construction costs handicap this solution very severely, and, moreover, short-circuit faults are more frequent with double overhead lines. An alternative is the use of a three-wire system, such as employed by the New York, New Haven and Hartford Railroad. Here the contact line and feeding line are joined at intervals by transformers, the mid-points of which are taken to the rails, which are sectionalised. Other methods of connecting sucking transformers are available, all, however, involving some difficulty.

Conclusions arrived at after this report were noted in Section 2 (*ante*).

Great assistance has been received from the Norwegian and Swedish railway authorities, who have put every information at our disposal. Our most grateful thanks are specially due to Mr. Overholm, the very well known electrical engineer of the Swedish State Railways, who is responsible for the design as well as the operation of all the railways electrified by the Swedish State.



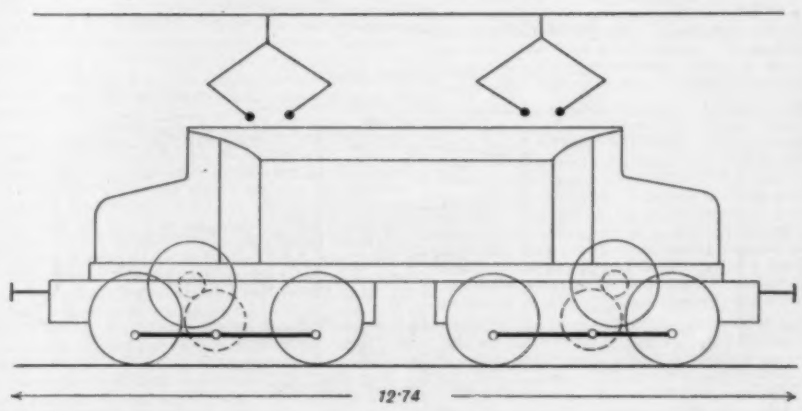


FIG. 9—ELECTRIC LOCOMOTIVES—KRISTIANIA-DRAMMEN RAILWAY

SOME FEATURES OF THE LONDON WATER SUPPLY.

AT a meeting of the Birmingham and District Association of the Institution of Civil Engineers, which was held on Thursday, January 29th, Mr. J. E. Willcox, M. Inst. C.E., President of the Association, in the chair, Mr. H. E. Stilgoe, M. Inst. C.E., chief engineer to the Metropolitan Water Board, delivered a lecture on "Some Features of the London Water Supply."

In the course of his remarks, Mr. Stilgoe stated that the area covered by the Metropolitan Water Board was about 558 square miles, and that the total population supplied was just over 7,000,000. The quantity of water distributed for the year ended March 31st, 1924, was 91,839.8 million gallons, being a daily average of 250.83 million gallons.

The water supply of London, apart from the magnitude of the undertaking, afforded, said Mr. Stilgoe, many problems for solution. Unlike that of a town supplied by gravitation by means of reservoirs and filter beds situated at commanding altitudes, the whole of London's water had to be pumped, in some cases in four operations. The water was pumped from the river intakes to the storage reservoirs. After filtration it was pumped into supply by different stages, according to the altitude of the localities. In many cases it was pumped literally into supply, as the large trunk mains *en route* to the service reservoirs also supplied some large distributing mains. The pumping engines were for the most part steam driven, about 180,000 tons of coal being burnt in the boilers annually.

The Board had also Diesel oil engines at four pumping stations. As a general principle, steam pumping engines were to be preferred when they ran, as did many of the Board's engines, for 80 to 90 per cent. of the year, day and night. The oil engines were, however, convenient and economical as a stand-by.

The new works at the Littleton Reservoir were described, as well as the sand and mechanical filtration and chlorinating plants. The lecture was illustrated by lantern slides showing works under construction.

There was a large attendance at the meeting, and a vote of thanks to the lecturer was proposed by Mr. F. W. Macaulay—Engineer to the Birmingham Water Department—and seconded by Mr. H. H. Humphries, the City Engineer.

Ship's Motor Lifeboat with Wireless Equipment.

ACCORDING to the new rules for life-saving appliances on merchant ships, which came into operation at the beginning of the year, it is compulsory to carry one motor lifeboat with a complete wireless equipment on all large foreign-going passenger vessels. On ships where more than fifteen ordinary lifeboats are normally provided, one such lifeboat must be included in the boat equipment, while two motor boats must be carried on all ships with more than twenty boats. This enactment has given rise to considerable competitive interest among marine motor and boat builders, and alternative designs have been prepared to meet the requirements of the Act.

A typical example of such a motor boat which we recently inspected is described and illustrated in the present article. The boat in question was designed and built by the Parsons Motor Company, Limited, of Southampton, in conjunction with the Despatch Motor and Lifeboat Company, Limited, of Southampton, which built the boat itself. Messrs. Parsons were main contractors and supplied the propelling machinery, whilst the wireless equipment was made by Siemens Brothers and Co., Limited, of Woolwich, to the order of the Cunard Steamship Company, the owners of the boat. We understand that this new boat will be carried on the liner Berengaria, which is now being prepared for her season's work.

Boat Particulars.—The general lines of the boat are indicated by Figs. 1 and 3. Her length is 28ft.; her beam, 8ft. 6in.; her depth, 3ft. 6in. approximately; and her draught, 2ft. She is carvel built, English oak being used for the main timbers, and teak, ¾in. thickness, for the planking. The decks, benches and bulkheads are of Oregon pine, and red seasoned pine is used for the engine beams, floor carlins and bottom boards.

The arrangement of the space in the boat is indicated in Fig. 3. The regulations call for seating for not less than twenty-eight to thirty passengers, which is provided in the large wells on either side of the engine-room. Beneath the seats are buoyancy tanks of sufficient capacity to meet the Board of Trade requirements, and stowage is also provided for the scheduled rations of water, biscuits and condensed milk. Immediately in front of the engine-room forward bulkhead is a raised steering platform, which is designed to give protection to the steersman and a clear view over the heads of the passengers. A compass and earchlight projector are fitted on the front of this platform. With its complete equipment, including the wireless installation, the boat weighs about 3¾ tons.

The Propelling Machinery.—The propelling motor—illustrated in Fig. 3—is a standard three-cylinder unit of the Parsons marine type, with direct coupled reversing gear. The cylinders have a bore of 4½in. with 6in. stroke, and are designed for an output of 21 brake horse-power, at a normal speed of 700 revolutions per minute when running on petrol. It embodies the firm's latest improvements in design, which include a separate cylinder jacket cover, the removal of which gives easy access to the cylinder cooling water spaces. At the after end of the engine the main bed-plate is extended to carry the reverse gear, which is of the sun and planet type, operated by a hand wheel. Ball bearings are freely used, both for supporting the wheels and for taking up end thrust, and the gear is simply and robustly designed. The engine is mixture-governed, and its speed is automatically controlled by an enclosed centrifugal governor fixed at the forward end of the engine. Magneto ignition is employed and an impulse starter is fitted, while coil and battery ignition gear is also provided for stand-by use. The engine is designed to start on petrol and to run on paraffin. The fuel is carried in two 25-gallon paraffin tanks, and one 2-gallon petrol tank, giving sufficient fuel for a cruising radius—at the regulation speed—of well over 200 miles. The tanks themselves are made of lead-coated steel, and are supported on trays with a drain overboard, so as to prevent any accumulation of fuel. As will be seen from the drawing given in Fig. 3, the paraffin tanks are stowed one on either side of the engine-room, while the petrol tank is placed slightly forward. The engine-room is metal lined and lighted by small port-holes, and at the forward end cowl ventilators are fitted. In rough weather, the doors at the after end may be closed, so as to protect the machinery from spray or sea water.

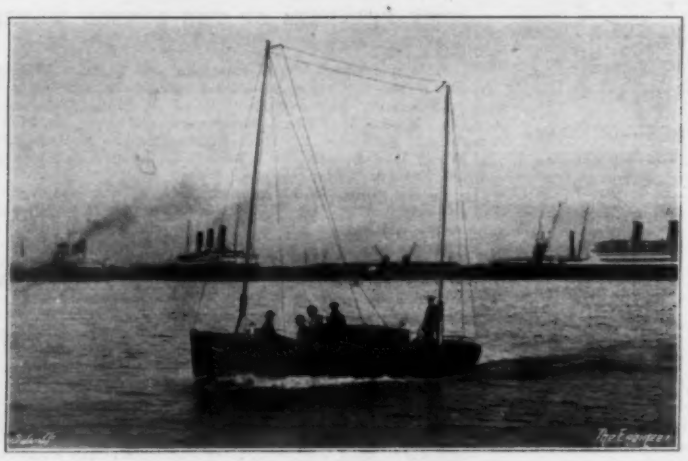


FIG. 1—SHIP'S MOTOR LIFEBOAT WITH WIRELESS EQUIPMENT

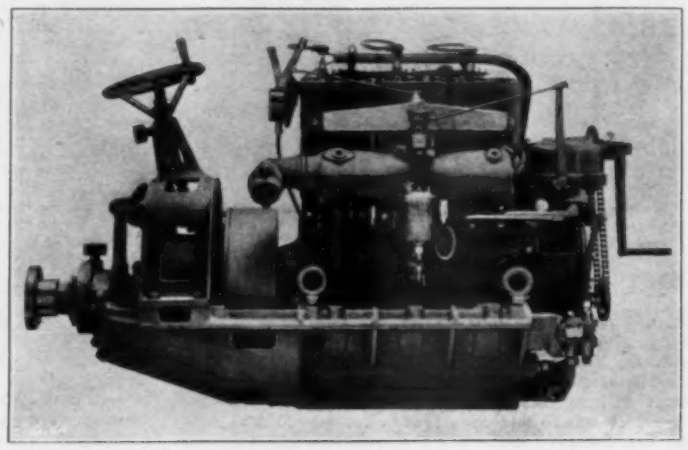


FIG. 2—ENGINE FOR MOTOR LIFEBOAT

Wireless Equipment.—The wireless equipment, which was supplied by Siemens Brothers and Co., Limited, is of a very simple type, such as may be used by anyone having a knowledge of the Morse code and some slight experience in the handling of wireless apparatus. It is fitted in the forward cabin, and comprises a transmitter and receiver tuned for a wave length of 600 m., which has been standardised for use in connection with safety of life at sea. The type of aerial employed is shown by Fig. 1. It is supported on bamboo masts, and is so arranged that it can be easily removed when the boat is stowed.

The transmitting apparatus includes a N.I.F.E. alkaline battery of from six to eight hours' capacity, connected to a motor generating set. The 20-volt direct-current motor is coupled to a self-exciting alternating-current generator, giving an output of about ¼ kilowatt at a pressure of 110 volts. The current generated by this machine is raised to a pressure of 4000 volts by means of a closed core transformer. It then feeds the excitation circuit comprising a Dubilier mica-condenser, a four-part quenched-spark gap, and an excitation inductance formed of copper strip. The variometer is of the cylinder-ball type. The coil is made variable, so that an accurate adjustment of the wave length is obtained. In a prominent position in front of the operator there is arranged a 500-cycle alternating-current voltmeter, which enables the operator to control the output of the generator, and an aerial ammeter which gives the current at the base of the aerial. The receiving apparatus is of the three-valve type, with a high-frequency valve, a rectifying valve, and a low-frequency valve. If necessary, the set can be worked with two valves, and for use in case of emergency, a crystal detector is fitted. The valves are worked from a tapping taken from the main battery. The whole of the transmitting and receiving apparatus is mounted on a shelf in the wireless operator's cabin, with the motor generator arranged below the shelf and the starting connections at the right-hand side of the operator. Simple instructions as to the working of the set are posted in the cabin, so that the necessary operations can be practised at boat drill.

Searchlight Equipment.—A neat searchlight, specially designed for boat work, is fitted. The projector has an 8in. glass Mangin mirror and illumination is provided by a gas-filled incandescent lamp, with a specially designed filament for focussing. The lamp has a capacity of 150 watts, and is run from a 12-volt tapping taken from the main battery circuit. Adjusting screws permit the projector to be focussed so as to pick up two objects 60ft. apart at 600 yards range, or, alternatively, it can be used for general illumination at close quarters. The base of the projector is fitted with turning, tipping, and locking arrangements, and it may be used to give a vertical beam for signalling purposes. The projector was designed and supplied by Siemens Brothers.

We were permitted to make some runs on the boat during its preliminary trials, when the machinery operated in a very satisfactory manner. The designed speed of the boat, as called for by the Board of Trade, was 7 knots, and on the official trials a mean speed just over 7¼ knots was obtained, which the builders claim is highly creditable for an engine designed to develop 19 brake horse-power when running on paraffin.

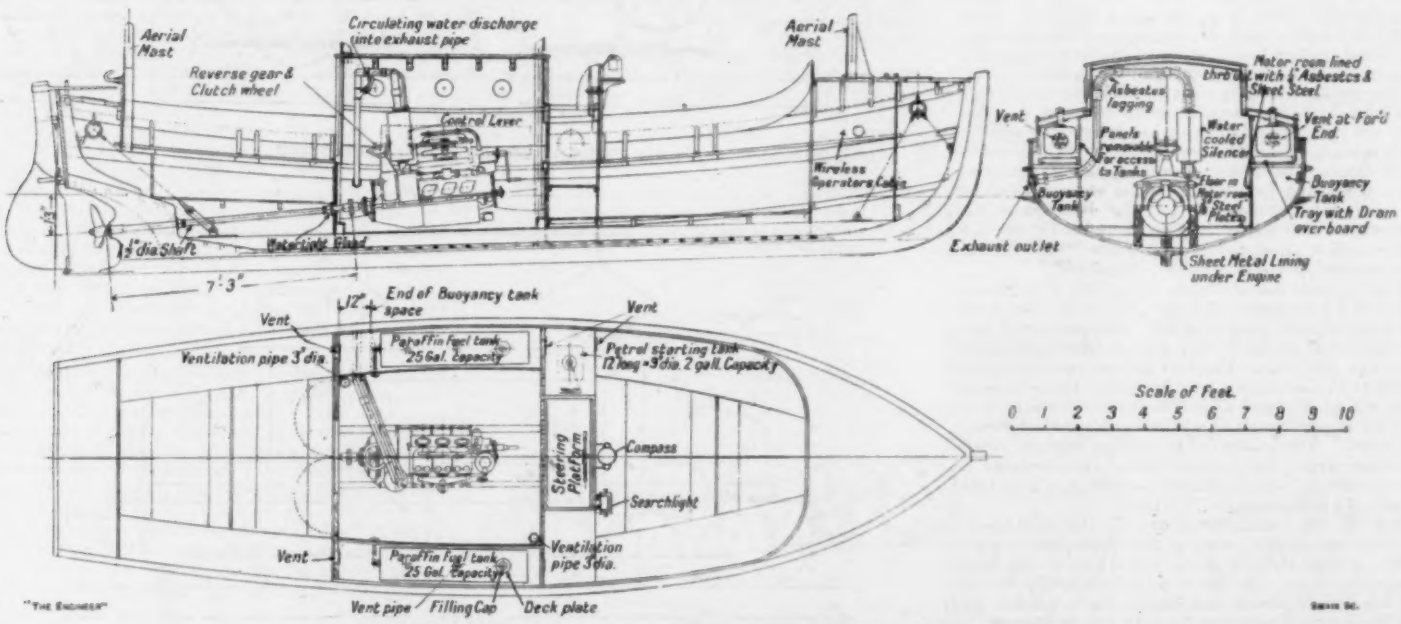


FIG. 3—SECTIONS AND PLAN OF SHIP'S MOTOR LIFEBOAT WITH WIRELESS EQUIPMENT

Railway Matters.

THE Ministry of Transport inquiry into the buffer-stop collision at Glasgow Central Station on the 24th ultimo was conducted by Colonel Mount last Thursday week. The evidence appears to suggest that some of the brakes were not acting properly.

AFTER four days' trial the driver concerned in the Haymarket, Edinburgh, collision of July 28th last, when five passengers were killed, has been acquitted on a charge of culpable homicide. The report on the accident by Sir John Pringle will be awaited with interest.

THE new electrical service on the Bombay Harbour branch of the Great Indian Peninsular Railway was opened on February 3rd. The line connects the harbour with the Victoria terminus. The line from the latter place to Thana, a distance of 21 miles, will, it is hoped, be available for electrical services in July, 1926.

THE Letterkenny and Burtonport Extension, which is worked by the Londonderry and Lough Swilly Railway Company, when running between Kilmacrenan and Creeslough, passes through one of the wildest bits of County Donegal. The Owencarrow is crossed by a viaduct 380 yards long and 40ft. high, and as the line runs almost due north and south a train crossing the viaduct would have, on its side, the full force of any westerly gale. On Friday afternoon last a heavy gale was blowing when the train from Londonderry was crossing and its strength derailed all the four vehicles behind the engine. They fell on the parapet wall with such force that they were broken open and the passengers thrown out into the valley below. Three passengers were killed outright and one died subsequently.

THE announcement is made that the London, Midland and Scottish Railway Company is re-numbering its 10,000 locomotives. Comprised in the London, Midland and Scottish group are 35 companies—8 constituent and 27 subsidiary—and, as a result of the amalgamation, it has become a matter of importance, from the operators' point of view, that the different types of engines should be classified numerically. For this purpose each of the present divisions of the system has been regarded as a separate entity, and each is to have its own block of locomotive numbers, as follow:—Midland Division, 1–4999; Western Division A, 5000–9999; Western Division B, 10,000–13,999; Northern Division, 14,000–17,999. The London, Midland and Scottish owns 10,344 locomotives, and, though this figure will be substantially increased as a result of the £14,000,000 scheme of new construction, many years must elapse before all the numbers in the present allocation are exhausted.

PRELIMINARY to arrangements for opening up for settlement the Peace River country in Northern Alberta, comprising about 20,000,000 acres of agricultural land, a conference of railway executive and Government officials was held at Ottawa on January 9th. Among those in attendance were the Hon. George P. Graham, Minister of Railways; the Hon. Charles Stewart, Minister of the Interior; President Sir Henry Thornton, of the Canadian National Railways; President E. W. Beatty, of the Canadian Pacific Railway; and the Premiers of Alberta and British Columbia. The conference was united in the opinion that the duplication of lines should be avoided, and the Minister of Railways stated that only one line would be authorised by the Government. It was decided that the executives of the two railway systems should conduct a joint investigation, and, if possible, agree upon a line in the construction and operation of which both lines could co-operate. Provided a satisfactory arrangement is effected, Parliament will be asked to pass the necessary legislation during the approaching session.

WE learn from the *Electric Railway Journal* (New York) that the efficiency of some eighteen classes of rail have been tested by the Boston Elevated Railroad at places where unusually sharp curves are found. The results at four curves call for mention. After 2½ years' experience on a curve of 90ft. radius seven Sandberg rails were found to be 115 per cent. better than the untreated rail previously in service there. At a second curve, also of 90ft. radius, two ordinary and three Sandberg rails were put in together. After six months the former had to be taken out and were replaced by open-hearth ferro-titanium untreated rails, but at the end of a further 22 months the treated rails were found to be 59 per cent. the better. Seven treated and seven untreated rails were laid alternately on a 420ft. radius curve, and at the end of two years and eight months the treated had worn 0.0109 square inch per million tons of service and the untreated 0.0232 square inch. The fourth curve had a radius of 1000ft. and on it 11 treated and 11 untreated rails were laid alternately on both inner and outer rail. At the end of two years the wear of the sorbitic rail in the inner rail was 204 per cent. less and in the outer rail 314 per cent. less than that of the untreated rail.

ACCORDING to the Board of Trade returns the value of the railway material exported during the first eleven months of last year was as follows, the corresponding figures for 1923 and 1922 being added in brackets:—Locomotives, £1,729,801 (£2,604,111, £4,785,110); rails, £1,493,066 (£2,306,748, £2,281,534); carriages, £1,080,787 (£904,756, £1,812,025); wagons, £3,074,608 (£2,811,218, £3,037,062); wheels and axles, £537,620 (£803,628, £1,100,970); tires and axles, £566,649 (£627,367, £391,588); chairs and metals sleepers, £1,106,587 (£857,776, £1,949,961); miscellaneous permanent way, £1,044,974 (£1,155,518, £1,284,753); total permanent way, £4,959,985 (£6,125,124, £7,178,045). The weight of the rails exported was 160,758 tons (258, 105 tons, 231,945 tons), and of the chairs and metal sleepers 88,195 tons (74,730 tons, 137,703 tons). During the month of November locomotives of the following values were shipped to the countries named:—South Africa, £16,500; Australia, £14,181; Ceylon, £4372; South America, other than the Argentine, £4250; India, £3389; together with £14,645 to unnamed countries in Europe, and £74,783 to countries other than the above. Of rails there were:—Argentine, £20,616; India, £15,957; Portuguese East Africa, £5977; Australia, £5597; New Zealand, £5586; British West Africa, £1747; South Africa, £357; and to countries other than the above, £54,145.

Notes and Memoranda.

A TELEPHONE diaphragm made of a combination of iron filings and celoron, which is a fibre and bakelite compound, is being placed on the market in America. The diaphragm may also be used in phonographs, radio apparatus, &c. It is said to be more delicate than metal, and has the peculiar property inherent in few substances in that it improves with age.

A BRIEF description was given in a recent issue of the *Electrical World* of an experimental fish escalator installed at the 125ft. Condit Dam in the Columbia River, Washington State, under the direction of Professor John N. Cobb. By this system, salmon on their way to the spawning grounds have been taken to the top of the dam in a single-basket conveyor and dumped on the other side without injury. Next spring further experiments will be conducted on the same site with trout, as well as experiments in getting the young fish down over the dam. The Condit Dam belongs to the North-Western Electric Company, of Portland, Ore.

PREPARATIONS are being made for the manufacture in this country of glue "pearls," to take the place of the usual cake form of glue. According to an article in the *Chemical Trades Journal*, the hot glue solution is allowed to drop through a perforated plate into a cooling bath below. The bath may be any one of several liquids, but a mixture of carbon tetrachloride and benzine is suitable. The pearls float on the surface of the bath at first, but as they cool their density increases, they sink, and are taken away by a conveyor. The pearls, now hard, are freed from adherent liquid and dried. The process occupies a fraction of the time required for the older method of evaporation.

IN the *Bulletin* of the Hydro-Electric Power Commission of Ontario, Mr. T. H. Hogg says that the best way of preventing trouble from frazil or other forms of ice is, of course, a large head water pond with a very low velocity, which will readily freeze over in winter time. This ice cover protects the water underneath, which never reaches a freezing temperature, and thus obviates all trouble from any form of ice. This protective effect is accomplished not only by the ice acting as an insulator proper, but also because the heat waves of the comparatively long length resulting from the low temperature of the radiating water cannot readily pass through the ice into the colder air, whereas the very short heat waves coming from the high temperature of the sun can readily pass through into the water.

LINEMEN and construction men, states our American contemporary, the *Electrical World*, frequently have occasion to throw a measuring tape over an energised circuit. There is a possibiity that the tape may contain metallic threads or that the paint may be a conductor of electricity, so in order to ensure safety one of the supply companies has arranged to test all such tapes. The tapes are passed over two electrodes, spaced 12in. apart, and the potential between the electrodes is maintained constant at 20 kilovolts. Two rubber rollers provide sufficient friction to unwind the tape from the container as soon as a crank is turned. The base of the testing apparatus is made of ebony asbestos board, all metal parts are lacquered brass, the tape holder, crank and supports are hard rubber, and the electrode supports are porcelain. The operator is perfectly safe when using the machine.

BEFORE very long, states the *Wireless World and Radio Review*, it is expected that Greenland will have in operation an entirely new system of wireless stations. Plans for such a scheme had been made prior to the war, but during the world conflict these had to be laid aside. At the conclusion of hostilities, however, plans were revised and the preparatory work resumed, with the result that during the Danish royal visit to Greenland in 1921, wireless connection was first established between the King's ship on the West Coast of Greenland and the International Telegraph Service. The stations now nearing completion are situated at Julianchaab, Godthaab, and Godhavn, on the West Coast, and at Angmagssalik on the East Coast of Greenland. The contract has been in the hands of the Danish Radio Company. The Julianchaab Station, constructed on the Poulsen-Arc system, employs a power of 5 kilowatts.

PARTICULARS of the water consumed in handling boiler ashes in a wet state are given in a paper by Mr. A. Hossack read before the South African Institution of Engineers. The boiler on which the test was made was burning coal at the rate of 4 tons per hour, and the weight of ashes discharged was at the rate of 1700 lb. per hour. Two extractor tanks per boiler, or one per grate, were used, and water at a temperature of 19 deg. Cent. was fed into each tank at the rate of 306 gallons per hour. The overflow from each tank was measured and found to be 256 gallons per hour at a temperature of 75 deg. Cent. The water absorbed by the ashes and otherwise lost amounted therefore to 50 gallons per tank per hour, or 100 gallons per hour per boiler. Relating these figures to the weight of coal burnt showed that the water lost amounted to 25 gallons per ton of coal burnt, and was equal to 59 per cent. of the weight of ash extracted.

THE Tafjord Power Development Scheme in Norway—the first 100,000-volt installation in Norway—has now been running satisfactorily for over a year. The power is generated at the head of the Norddals fjord at a distance of about 75 miles from the town of Aalesund. Later on two more waterfalls will be harnessed. On the main line the pressure is 100,000 volts and for the distribution system the pressure is 20,000 volts, which is reduced to 220 volts for the consumer. This pressure permits the use of a trustworthy submarine cable. The Nörve substation supplies Aalesund and several islands in the Atlantic Ocean at a considerable distance from the mainland. The total length of submarine power cable at present in use is 17 miles. The generators are three-phase, made by the Oerlikon Company, and are designed for a normal continuous rating of 7300 kilovolt ampères at 7000 volts. Each generator works in conjunction with an Oerlikon transformer of the same power and having a voltage ratio of 7000/113,500 at light load. The oil is cooled outside the transformer in a separate oil cooler.

Miscellanea.

IT is proposed to build a suspension bridge across the Firth of Forth at Queensferry. There would be two spans of 2400ft. each. The cost is estimated at about £4,000,000.

WHAT is claimed to be a world's record was recently made at the Richmond Main Colliery, New South Wales, when 3097 tons of coal were wound in a day from a single shaft.

THE cable between Vancouver and Fiji is to be doubled by the Pacific Cable Board. There will then be duplicate cables all the way from Canada to Australia and New Zealand.

THE Soviet Government has prohibited the importation of white lead and the establishment in Russia of new white lead factories. The use of white lead paints after 1930 is prohibited.

THW University of Pittsburg contemplates the construction of a 52-storey building at a cost of 10,000,000 dollars to house all departments except those of medicine and dentistry.

A COMPANY with a capital of 10,000,000 lire is constructing a plant at Bussi, Province of Abruzzi, Italy, for the manufacture of synthetic ammonia by the Claude process. The company is controlled by a Swiss group. Surplus electric power, generated by the company which supplies Naples with electricity, will be utilised.

A SPECIAL commission appointed to consider the question of the electrification of the railways in the Belgian Congo has just presented a report in which it is recommended that the first 50½ miles of the Congo Railway be immediately electrified and that a company be formed to establish hydro-electric plants to utilise water power in the Lower Congo.

A MORNING test between American and Swedish wireless amateurs, organised by *Radio-Bladet*, and under the control of the American Relay Radio League, was carried out from 7 to 9 a.m. on Sunday, February 1st. The Americans undertook the transmission side of the test, whilst the Scandinavians endeavoured to "log" as many Americans as possible in the time at their disposal.

ACCORDING to our American contemporary, *The Telephone Engineer*, Dr. Michael I. Pupin, the engineer and inventor responsible for important advances in telephone communication, has been elected president of the American Association for the Advancement of Science. He is professor of physics at Columbia University, New York, and his autobiography, "From Immigrant to Inventor," recently created great interest in both scientific and lay circles.

DEEP sea ships to the number of 1002 entered Vancouver Harbour last year, as compared with 837 the previous year. Vancouver exported 698,359,500ft. of lumber, as compared with 209,766,412ft. in 1923, a new high record in the history of the port. Grain exports totalled 55,873,788 bushels, against 24,663,017 in the previous year. Altogether, 1,579,811 cases of tinned fish were shipped in the last twelve months, as compared with 963,866 cases in 1923.

THE Arapuni hydro-electric scheme, New Zealand, for the installing of which Sir W. G. Armstrong, Whitworth and Co., Limited, are the contractors, is, according to the *Industrial Australian*, now fairly commenced. The excavations for the great dam are in hand on either side of the Waikato River, while the driving of the river diversion tunnel, from the outfall end, is proceeding. A constant stream of machinery and materials from England is now arriving for the contractors.

A BEGINNING has been made with the laying of the long-distance cable between Prague and Kolin. The construction of direct telephone circuits between Prague and Trieste is practically completed so far as the Czecho-Slovakian portion is concerned. On the Italian portion the work is so far advanced that traffic is expected to be possible early this year. Thereafter communication will be established with Paris, through Nuremberg and Strassburg, the constructive work being prosecuted actively, both on the French and the German sides of the frontier.

A NEW line of cable, about seven miles in length is, states the *Electrical Review*, about to be laid which will link up the Yorkshire Main Colliery at Edlington with Hickleton Main Colliery, and the completion of this will put an electrical girdle round Doncaster. The line may later be extended to Frickley, bringing in Grimethorpe and the Brierley pits, which are now building a central power station for transmitting power at 20,000 volts. Each pit in the Markham group has its power station, and the idea is to guard against the effects of a breakdown. The Doncaster Corporation and the Doncaster railway works are taking part of the surplus energy generated.

ACCORDING to the Chief Inspector of Mines in India, the total output of coal in British India during the year 1923 was 18,763,967 tons, which is 594,979 tons more than in the previous year. The total despatches of coal amounted to 15,510,104 tons, and 2,356,814 tons were consumed on the collieries. The quantity of coal used for coking at the collieries was 451,667 tons, and 82,841 tons of hard coke and 220,061 tons of soft coke were made. At a large number of collieries coal is now despatched from the collieries to coke-making plants elsewhere, and this coal is included under despatches. These despatches of coal to coking plants amounted to 762,257 tons in 1923.

THE New Zealand Minister of Customs has decided that certain classes of iron and steel, made wholly in Great Britain or other British Possessions from iron of foreign origin, shall until April 1st, 1926, be regarded as wholly of British manufacture for the purposes of clause 5 (a) of the combined certificate of origin and value, under the new regulations regarding the application of the British Preferential Tariff. This implies that the goods specified will be entitled to be entered for duty under the preferential tariff, even though 75 per cent. of the factory or works cost is not represented by British material and/or labour. The list includes bar, bolt, rod, angle, tee, channel, girder, hoop, plate, or sheet iron or steel made from foreign pig iron and iron billets and blooms.

SIMLA WATER SUPPLY—NEW 4200FT. HEAD PUMPING STATION

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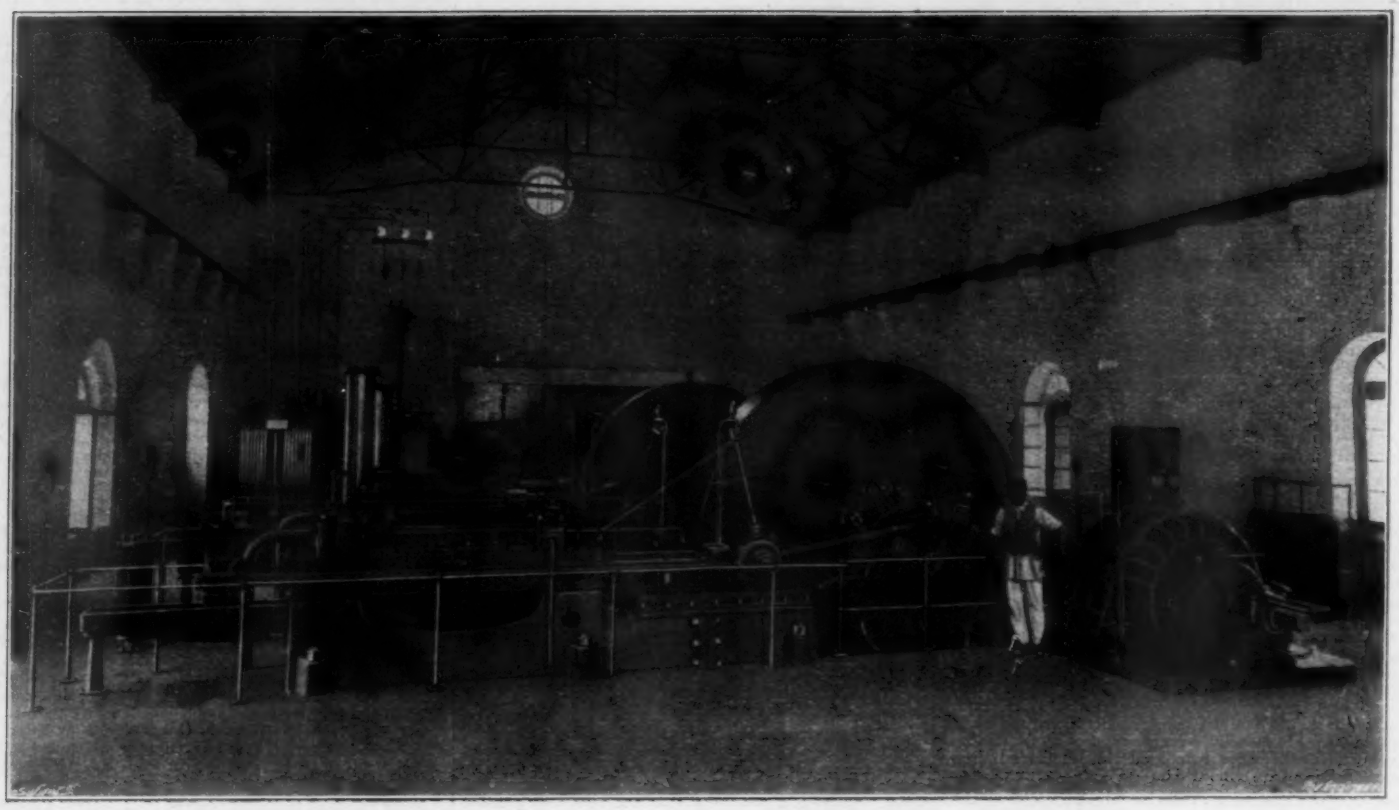
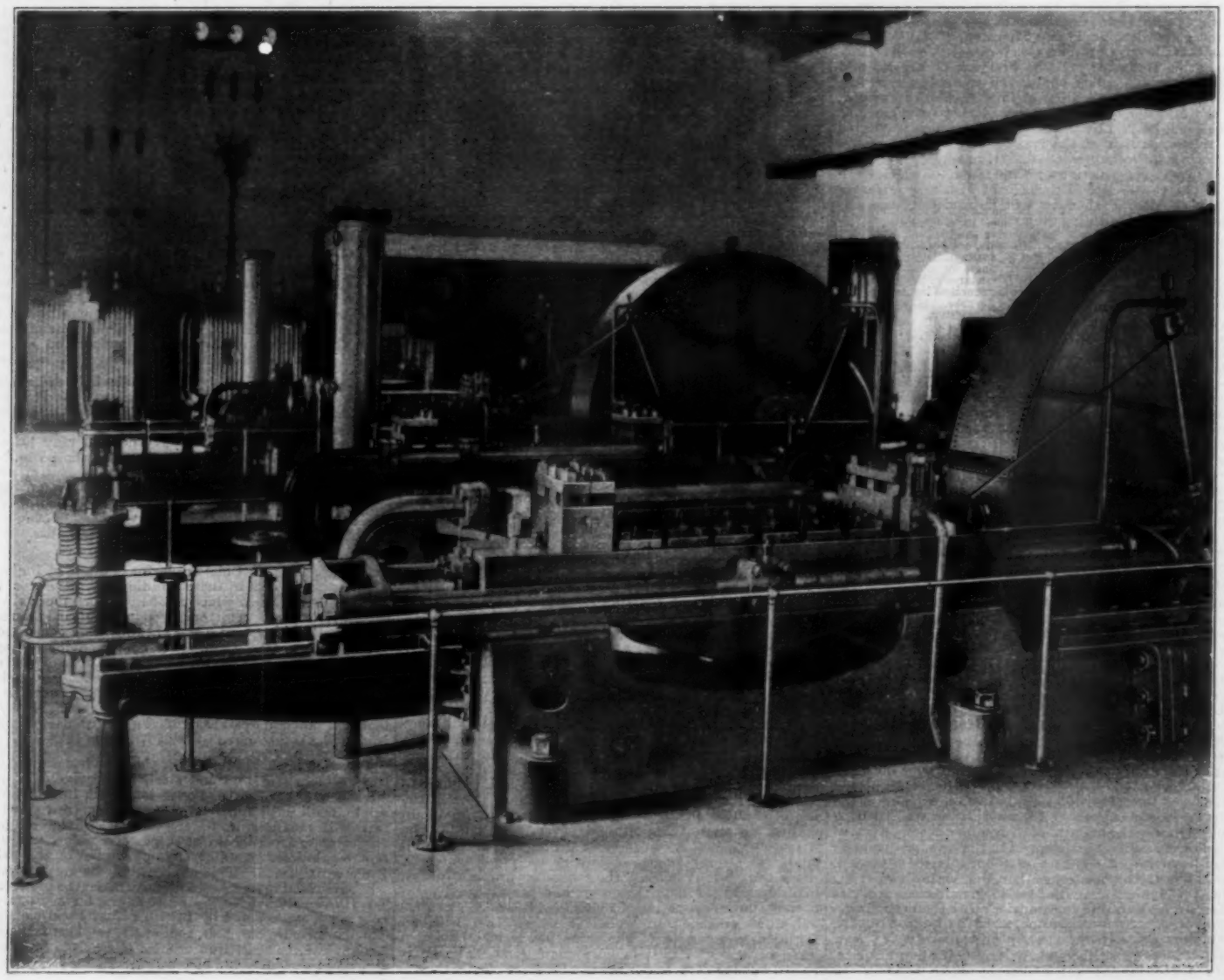
(For description see page 167)





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TWO-PAGE SUPPLEMENT—SIMLA WATER SUPPLY: PUMPS FOR 4200FT. TOTAL HEAD.

DEATH.

On Tuesday, February 3rd, at Torquay, OLIVER HEAVISIDE, aged 70.

THE ENGINEER.

FEBRUARY 6, 1925.

The Philosophy of Cutting.

WE are glad that in the short letter which he contributes to our correspondence columns to-day Dr. Stanton lays stress upon the fact that the research upon which a committee of the Institution of Mechanical Engineers is now engaged is directed to the discovery of the fundamental principles of cutting. A great deal of work has been done on the practical, or workshop, side of metal cutting with all kinds of tools from files to milling machines, and it is very doubtful if, for the present, any useful results would accrue from further pursuit of the inquiry in that direction. It must never be forgotten that every well-organised machine shop is a research laboratory on a large scale. It only differs from smaller laboratories in that it is concerned rather with economics than with "science," and that it has perforce to deal with averages and broad general facts and not with scientific minutiæ. The works have found that certain top-rakes or cutting angles give the best result for steel, cast iron, brass, bronze, &c. They have tried angles differing on each side from the standard angles and have satisfied themselves that, though for a specific case here and there the change may be beneficial, yet for all-round work the accepted angles—which, it must be remembered, were established in large measure by scientific research—cannot be beaten. If these angles are not used, if the tools are so set in the machine that the actual "top-rake" is not what it is assumed to be—there is not always sufficient care in getting the point of the tool on the centre line—the fault is the fault of the management, and no amount of scientific investigation can put it right. Hence we may say that the best angles on an economic basis are already known, and further research into them could only be a repetition of what has been already done over and over again in the past twenty years.

It was quite clear, then, that if the Cutting Tool Research Committee was to do further useful work it would have to attack the problem of cutting from a different aspect, and its decision to adopt the admirable suggestion of Mr. William Taylor cannot have been long in doubt. The fact is that we know uncommonly little about the philosophy of cutting. We have perhaps regarded it—particularly when long smooth spirals of steel have been turned from a well-lubricated bar—as a gentle process of removing metal by insinuating a fine cutting edge into a yielding material. Professor Coker's fascinating revelation by polarised light of the cutting of celluloid showed us indeed the region of stresses, but did little to remove that impression. It remained for Dr. Rosenhain to convince us by micro-photographs that cutting, in some cases at least, is a "brutal" process, that it compresses and distorts the metal locally, and that it rends the particles apart rather than separates them by gentle insinuation of a cutting edge. He tells us that even when we shave with a keen razor we do not give a clean cut to the stubbly hairs, but sever them by forcing a relatively large wedge through them. That is a good beginning for a real philosophy of cutting—recognition of the fact that the process is a brutal one. But even on it a great deal remains to be said. Perchance the keen edge of a razor acts very differently from the blunt edge of a metal cutting tool. That it is far less "brutal," anyone who examines the microtome section of delicate organic structures may readily satisfy himself. Under the high-power microscope any serious distortion of the cell walls of the materials would be plainly visible. That it is absent would appear to indicate that the "brutality" is so slight as to be practically non-existent; in other words, it shows that a sufficiently fine edge can be insinuated between the particles of which organic substances are made, and that they can be separated without rough distortion. Another point in connection with fine cutting edges occurs to the mind. We have all seen Japanese jugglers ascend on their bare feet a ladder of swords with which only a few moments before they had cut paper. We know well enough that if their feet were not carefully placed so as to avoid any sliding, the performance would end in bloodshed. Again, we have all seen in operation the plain circular discs which are used for slicing our morning rashers. If the discs were at rest the pressure of the bacon against them would result in very indifferent cutting, and in none at all unless the pressure were great. But rotate the disc, and the whole operation becomes one of ease and perfection. Many such cases present themselves. Consider, for example, the difference between the pressure cut and the slicing cut of a paring chisel, the latter leaving a glossy finish which the other cannot attain. Or, again, why will an inclined blade cut smoothly when one presented straight against the object will not cut at all? We shall no doubt be told that no edge is continuous, that every edge is more or less saw-like, and that the sliding cut owes its efficiency to these minute defects. Is that, we ask, true also of a fine drawn wire which makes a fairly efficient knife if pulled to and fro, but is valueless without longitudinal movement? The difference between such cutting tools as these and those used by the mechanic is, it is true, very great, but the elucidation of their action may throw light upon the action of others. The cutting of crystalline materials like steel and bronze may bear no resemblance to the cutting of homogeneous material like celluloid, or fibrous material like wood. Yet there will probably remain something akin in the processes, and when we arrive at the true philosophy we may find that it is applicable to all kinds of cutting. So far, examination has been directed to the material acted upon, to the material in the process of removal, and to the total forces upon the cutting tool. We assume that as the research proceeds the tool itself will receive examination. A micro-photograph exhibiting the stresses in it could not be less interesting than those showing the effect of stresses on the work. Some engineers hold that cutting takes place at the tool edge, others that the actual edge is never in contact with the work once the cut has been started. Until this point has been settled it would be fruitless to consider the pressure per square inch of cutting edge. In a keen-edged tool—if the edge touches—it must clearly be enormous, and hence local heating of considerable intensity must occur. What part does it play in the act of separating the chip from the work?

If the nature of the research as revealed by the first reports may appear to be wholly philosophical, yet one practical point of the first importance would appear to have been revealed by Dr. Rosenhain. After showing that the work was torn and roughened by the cut, he suggested that, unless the greatest pains were taken to remove the damaged material at the surface by a fine finishing cut, minute cracks, particularly dangerous and insidious at fillets, might remain. The weakness of the re-entrant angle is well known, and Professor Coker has shown by his optical method how forces concentrate at such places, but hitherto a complete explanation of failures at such angles when

rounded, has been lacking. If it is provided by the defect which Dr. Rosenhain discussed, then, even at this early stage, the research will have reached a practical issue of no small importance. What further it may have in store for us none can say, but we may rest confident that a complete philosophy of cutting will not be wholly fruitless to the practical engineer.

Telephones.

THE unsatisfactory position of Great Britain as regards telephonic communication is a matter that has often been discussed, and in his presidential address delivered before the Institution of Electrical Engineers in 1922 Mr. Frank Gill, of the Western Electric Company, went so far as to say that drastic telephone reforms were needed in the whole of Europe. Given adequate facilities, he said, there was traffic waiting to be handled between the cities of Europe in the same way as it was handled in the United States, where the telephone system was of a gigantic character. But Mr. Gill was dealing mainly with long-distance communication, and there is another aspect of the matter which concerns Great Britain in particular. Just as it can be shown that Great Britain is behind various other countries in the use of electricity for lighting, power and domestic purposes, so it can be demonstrated that it stands in a very unfavourable position as regards the use of the telephone. Countries such as Luxemburg, Holland, Germany, Switzerland, Australia, Norway, Sweden, New Zealand, Denmark, Canada, and the United States all make use of the telephone to a much greater extent than ourselves; in fact, among the countries of the world Great Britain takes the fourteenth place in respect of the number of telephones per 100 of population, which is the usual measure of telephone density. No one will argue that our telephone service is as perfect as it should be or that it is impossible for any other service to be better; but it is difficult to conceive that the imperfections of our system are responsible for the position in which we find ourselves. The opinion of those who are qualified to speak authoritatively on the subject is that the people in the countries to which we have alluded have obliged the telephone authorities to put down plant to meet their requirements; in other words, they have learnt to appreciate the value of the telephone, whilst the people in Great Britain have not.

An effort is now being made by the British manufacturers of telephone and apparatus and plant to improve the situation so far as it is within their power, and a Telephone Development Association, corresponding to the Electrical Development Association, has been formed with the object of popularising and extending the use of the telephone and to secure its recognition in social and business life. With these objects in view an extensive publicity campaign is to be undertaken. Everything that is possible is to be done to educate the public to use the telephone on a wider scale, so that the volume of the telephone manufacturing business of this country may be increased. Recently the Association put its case before the Postmaster-General, but with what effect we do not know. One obstacle to the more general use of the telephone is, of course, its cost, an item which unfortunately often stands in the way of the attainment of other little luxuries which many of us would like to enjoy. A great number of people would no doubt have telephones fitted in their private houses if they could get them on more reasonable terms than those which now prevail. On the other hand, there are some business men in this country, at any rate, who, when they leave their offices at night, like to think that they have finished with the telephone until the next day, although in America the ringing of telephone bells is apparently regarded as a blessing rather than a nuisance. But it is difficult to argue against the use of the telephone, even in the home, as we have already said. Many more people would have them installed if they could do so on more reasonable terms. In a publication just issued by this new Association we find a lot of interesting figures and facts about the progress of telephonic communication in other countries, yet no attempt is made to throw any light on relative costs or any special arrangements which the foreign telephone concerns may have with their subscribers. The rapid developments in other parts, and especially in America, are attributed mainly to a resolute and well-directed campaign of education of the public and of the existing users. For years past the telephone concerns of the United States have conducted an educational campaign at enormous cost. Canvassing was at one time adopted on an extensive scale, but the large natural growth of the business has now made it unnecessary. We do not suppose for a moment that the British Post Office will ever employ a large staff of canvassers, especially now that an organisation has been brought into existence for the sole purpose of boosting the telephone. This organisation, it is worthy of note, does not profess to hold any brief for or against the Post Office. It is merely dissatisfied with the fact that Great Britain is not leading the way in the use of the telephone, and it believes that the remedy lies very largely in the hands of the public and that the first step is to make the actual position generally known.

Propaganda seems to be regarded as the root of other countries' successes or, at any rate, at the root of those of America. Many a power station engineer who has visited the United States has returned to this country loud in praise of the business organisation of the American supply undertakings, one of the most recent being Mr. W. H. Patchell. The business abilities of the American canvasser and salesman are alleged to account for the large consumption of electricity per head of population, as compared with the consumption in this country, and it seems that the same or a very similar argument can be used to account for our position with regard to telephones. All we hope is that our backward condition is not due to anything more serious. Is the relatively large use of telephones in such places as Denmark, Sweden, Norway, and Switzerland attributable mainly to propaganda or to other causes which may have been overlooked? Let us by all means endeavour to stimulate the use of telephones with the aid of advertisements and kindred schemes, but let us also try to discover exactly how it is that telephones have become so popular in other countries and are more abused than used in this. More general use of the telephone would benefit many industries, for telephone engineering involves the manufacture of a large variety of articles and the use of many raw materials which are handled by many people outside the actual telephone manufacturing business. Cables, for instance, require large supplies of lead, copper, paper and cotton, whilst in the manufacture of telephone instruments such materials as wood, brass, iron, copper, silk and rubber are used. Moreover, the telephone service calls for the aid of accumulator makers, makers of conduits, insulators and so forth, whilst the laying of cables gives much work in the way of opening up and the renewing of roadways. In these days when unemployment is so prevalent an extension of the telephone system would undoubtedly do a lot of good, and if the promoters of the Telephone Development Association succeed in making the Government spend the large sums of money which its programme appears to contemplate it will deserve the thanks of the nation.

Obituary.

CHARLES HENRY WORDINGHAM.

THE death of Mr. C. H. Wordingham, which occurred on Wednesday, January 28th, has removed from the electrical profession an energetic and distinguished worker, who took an active part in the early development of electricity supplies. Subsequently he became associated with other important developments, notably those appertaining to the use of electricity in the Navy.

Mr. Wordingham was born at Twickenham in 1866, and between the years 1876 and 1882 he was at King's College School. From 1882 to 1885 he studied engineering at King's College, where he was awarded a special certificate of honour, and was elected Associate of the College. On the completion of his theoretical training he was articled to the late Dr. John Hopkinson, who put him in charge of his laboratory. Under Dr. Hopkinson's guidance he carried out a large amount of original research, and assisted generally in his principal's consulting work. On finishing his time with Dr. Hopkinson, he accepted an appointment with the United Telephone Company, and was engaged in the erection of telephone exchanges. In 1889, however, he abandoned that work to take up a post as third engineer at the Grosvenor-road generating station of the London Electric Supply Corporation, where he gained valuable experience, and on the removal of the station to Deptford he was put in charge of the standardising department and distribution system. Needless to say, Mr. Wordingham again found ample opportunities for acquiring good experience, for in those days mains and meters were far from perfect. Many of the difficulties that were met with were referred to in his contribution to the Commemoration meetings of the Institution of Electrical Engineers, which were held in 1922. "I can well remember," he said, "the introduction of meters on the London Electric Supply system, for some of the consumers had found that their accounts had dropped to one-third, whilst others found theirs trebled."

In 1892 Mr. Wordingham returned to Dr. Hopkinson, who made him his assistant, and in that capacity he supervised and carried out the contracts for the erection of the central stations at Manchester and Whitehaven. In December, 1893, he went to Manchester to organise the staff and the working arrangements of the station; whilst in March of the following year he became chief electrical engineer to the Manchester Corporation. In July of the same year he took over the additional duties of consulting engineer. Two years later he was offered an exceptionally good post in London, but was induced by the Manchester Corporation to enter into a four years' agreement.

During that period, which expired in March, 1901, he acted as the Manchester Corporation's sole electrical adviser. He extended the original station from 2200 horse-power to 12,000, and designed an entirely new low-pressure station of 14,000 horse-power capacity and a high-pressure three-phase station, the two latter stations being intended for both lighting and traction. The area of supply was extended from about half a square mile to about 45 square miles, including the districts of a number of adjoining local authorities. Mr. Wordingham worked out all the schemes for supplying electrical energy for all purposes, including traction, and for the conversion of some 100 miles of horse tramways, as well as the equipment of about 38 miles of new tramways. He was also responsible for the electrical equipment of the cars.

At that time the Manchester electricity undertaking attracted a good deal of attention, mainly because, in

CHARLES HENRY WORDINGHAM

the absence of 200-volt lamps at that period, the five-wire system was adopted. It can well be imagined that a system of this kind was not put into operation without troubles. Considerable difficulties were experienced in the direction of balancing it, but under Mr. Wordingham's supervision those difficulties were satisfactorily overcome. The developments that subsequently took place at Manchester show how successful the early work had been.

Although the work which Mr. Wordingham undertook at Manchester must have made great demands upon his time, he, nevertheless, devoted himself about that period to the task of extending the activities of the Institution of Electrical Engineers by setting up local centres throughout the country. During the whole of his professional career, in fact, he did an immense amount of work of that nature. He served on numerous committees and took an active part in the work of various institutions.

When his agreement with the Manchester Corporation came to an end, Mr. Wordingham declined to renew it, and he started in practice as a consulting engineer. This practice he carried on for a period of rather more than two years, during which it rapidly grew, and he undertook a considerable amount of parliamentary work in connection with various power company's Bills. He also advised local authorities and private clients on traction and lighting schemes. In June of 1903 he was offered the post of Electrical Engineer-in-Chief to the Admiralty. He accepted the appointment, and held it until 1918, when he retired and again started in business as a consulting engineer.

At the time when Mr. Wordingham took up his position with the Admiralty, the British Navy had fallen somewhat behind in the use of electricity, but notwithstanding considerable difficulties, he introduced many reforms which proved effective during the Great War. As head of the electrical engineering department of the Admiralty, he was not only respon-

sible for the electrical equipment of warships, but he was also the adviser in connection with all the electrical work in the dockyards and kindred establishments. His work did not, it is true, always escape criticism, for the work of a Government official seldom does, but it is generally admitted, we think, that whilst with the Admiralty he rendered extremely valuable service. It was the vigour of his methods and the exacting nature of his requirements that gave rise to criticism rather than anything else.

Mr. Wordingham was President of the Institution of Electrical Engineers during the years 1917 and 1918, having previously been chairman of the Manchester Centre. He was a member of the Institute of Metals, a Past-president and honorary member of the Incorporated Electrical Association, a member of the British Engineering Standards Committee, an associate of the Institution of Naval Architects, chairman of the British Electrical and Allied Manufacturers' Research Association, a member of the British Section of the International Electro-technical Committee, a member of the General Board and Executive Committee of the National Physical Laboratory, and a member of the Council of the Electrical Development Association. Originally he was chairman of the Institution of Electrical Engineers Wiring Rules Committee, but on account of failing health he was unable to take an active part in the final preparation of the latest rules, which have recently been published. He was the author of many papers and technical articles, and was also responsible for a book on "Central Electric Stations."

Literature.

A History of Bleaching. By S. H. HIGGINS, B.A. London: Longmans, Green and Co. 1924. Price 10s. 6d. net.

THIS is a really delightful book; at any rate, to those who are subject to the charm of history. It is in a measure technical, but in a larger measure human and economical, and on nearly every page one may find some fact that stirs the interest or some historical note that seems to bind the past with the present. Mr. Higgins opens with a brief review of bleaching in the earliest days, in Egypt and Pompeii, and by the ancient Gauls and Britons. Bleaching was in those times carried out with the help of herbs and earths which had alkaline properties. In Pompeii the washing was carried out in marble-lined rooms, known as *fullonica*, by men, women and boys known as *fullones*. The name has descended to us in the form "fuller."

Many people believe to this day that the use of lime for bleaching is injurious to the fabric—a belief which Mr. Higgins is at some pains to dispel—and it is therefore of interest to note that early in the eighteenth century lime was prohibited by Act of Parliament. As usual, when law opposes technical progress it comes a cropper, and, despite the Act, lime continued to be used. But bleaching for a very long period depended upon exposure to the sun, and Mr. Higgins tells us that "in the Vale of Leven rows of beautiful beech hedges were planted . . . to protect the cloth that was being bleached on the grass from being blown away." Are any of our modern industries adding to the rural beauty of the countryside?

We come across many famous names in these pages, and amongst them that of Dr. Home, of Edinburgh, whose views on the application of science to industry appear modern—even do-day. We wish we had the space to quote them in full, but must ask our readers to judge whether we are right or not from a few small samples. "I find," wrote Home, "the most skilful bleachers understand the general theory of their art tolerably well, but being ignorant of the principles of chymistry, cannot make proper use of this theory or apply their knowledge to the advancement of their art. . . . There is nothing promotes an art faster than the communication of those who practice it; nothing retards it more than a selfish spirit of keeping all a secret. It is by a gradual process, when one refines upon the inventions of another and not by the endeavours of a single person, that arts arrive at perfection. . . . Let those who shelter themselves under the appearance of secrets know that ignorance always does the same." Dr. Home clearly had not only sound views but an admirable pen with which to express them.

Mr. Higgins devotes a couple of chapters to the English Development and to English Works. They contain many interesting notes and passages. We apparently owe the introduction of bleaching to the Flemings, as we do several other industries. They brought the craft to Manchester—where they were known as Walkers—and Walker's Croft, where they laid out the cloth for bleaching in the sun, endured in Manchester up till 1816, when it was converted into the burial ground on which Victoria Station now stands. Many other examples of place-names associated with bleaching are to be found in this kingdom, and it is curious to note that such as Blackley, Blackford, Blackburn, and so on, owe their origin to the whitening of fabrics, for in Anglo-Saxon, Mr. Higgins tells us, "black" meant "bleach." Perhaps it would have been wiser to spell it blaec, though oddly enough the same word meant both black and white in Anglo-Saxon. Industries were even more under the laws two and more centuries ago than they are to-day, and we find that the stealing of cloths from these crofts or bleach-greens was a capital offence even up to as late as 1786, when a man was executed at Bolton for carrying off two shillings worth of cloth from Mr. Tweat's bleaching ground.

Skipping many pages, we come to Chapter VI., which opens with the words "The introduction of chlorine as a whitening agent formed an absolutely new era in the bleaching industry." Scheele it was who discovered chlorine and its properties. It was called dephlogisticated marine acid gas because it was thought to be muriatic acid with the "phlogiston" removed. It seems probable that it was used on the large scale for bleaching in 1787. But the gas even when dissolved in water was extremely obnoxious and the value of Berthollet's discovery that the addition of alkali to the chlorine liquor deprived it of its suffocating effects without destroying its bleaching qualities is, therefore, readily understood. But it was Charles Tennant, of Glasgow, who really solved the difficulty by introducing a combination of lime and chlorine. He obtained a patent in 1798 for the process, but a few years later it was upset on the grounds of anticipation. Indeed, there is some reason to believe that Tennant appropriated the invention of a chemist named Hugh Foy. At any rate, the judge, so Mr. Higgins tells us, said the patent was a scandalous one, as unfounded in all sorts of merit as it was in law. "Tennant thus lost his case . . . but it must be admitted that in developing the use of lime for absorbing chlorine he did a lot of good for the development of the bleaching industry."

We have noted that the employment of chloride of lime marked one revolution in the art of bleaching; the next revolution belongs to the engineer and not to the chemist. One of the greatest costs in bleaching was caused by the frequent washings of the material, and when Messrs. Brooks, of Bury, brought out what is known to this day as the long-roller machine, the cost of washing was very greatly reduced. The Brooks plan was to stitch all the cloths together in a long line and pass them continuously through the bleaching and washing vats consecutively. There is an interesting item in connection with this and similar machines. The rollers stretched the material, with the result that 40 yards of cloth became 41 yards. The odd yard was the perquisite of the bleachers, and it is said that some of them made a profit of from £2000 to £3000 per year in that way.

Now we must leave a book which we have read with great pleasure and which we commend to all who are interested in the history of industry, and even to those who are not, for some of them at least, it will fill with a desire to know something of events which have had greater effects upon the world than all the soldiers, politicians, statesmen and law-givers have ever produced.

SHORT NOTICES.

Electric Circuits and Installation Diagrams. By W. S. Ibbertson. London: E. and F. N. Spon, Limited. Price 10s. 6d. net.—As the title implies, this is a book of diagrams. It has been compiled for the use of electrical engineers engaged in the operation and control of all kinds of power and lighting plants and installation work generally. The problem of how to connect up various pieces of electrical apparatus and machines undoubtedly sometimes presents difficulty to wiremen and others, but we scarcely think that all the diagrams which the author has given are really essential to electrical engineers. In any case, manufacturers of electrical plant and apparatus generally supply all the information that is needed relating to the connecting up of new electrical apparatus and plant. We do not by any means consider, however, that the book is devoid of value. A collection of diagrams such as that which the volume contains is almost sure to prove useful at times to many who are engaged in electrical work. Students and a very fair number of practical men will find the volume worthy of a place on the bookshelf.

Bituminous Substances. Scientific Progress of Practical Importance during the Last Fifteen Years. By P. E. Spielmann, Ph.D., B.Sc., F.I.C., A. Inst. P. London: Ernest Benn, Limited. Price 15s. net.—In spite of the title, this book is not written for users of bitumen, whether engineers or not. It is a text-book of highly specialised nature for the use of analytical chemists. It describes new laboratory methods for testing bituminous substances, as well as the chemical composition of component parts of these highly complex compounds. Penetration tests by the loaded needle or disc method are given in detail, and standard methods of analysis, such as applied to bitumen derived from distillation of crude petroleum, are described. Testing as known to engineers for the practical elucidation of the properties of bituminous concrete is outside the scope of this book, which is extremely interesting to the chemist as a step towards the unification of methods. The author's long connection with this class of work vouches for the accuracy of the volume.

Sanitation and Plumbing. By R. H. Bew. London: Blackie and Son. 1924. 7s. 6d. net.—The author says in his preface that "this book has been designed to give in an elementary form the facts and principles of sanitation and plumbing, with some appropriate applications," but we feel that he has been too modest in his description, for the reading matter which he has provided is of such an eminently practical nature that "elementary" seems to be hardly an appropriate term. Certainly the veriest novice can read the book straightforward, but, on the other hand, how many skilled plumbers are there who could set out the development of the envelope of a conical spire meeting a sloping roof—one of the problems explained by the author. We must congratulate Mr. Bew on producing a very practical work.

Friction Clutches. By R. Waring-Brown. London: Sir Isaac Pitman and Sons. 1924. 5s. net.—A fairly useful little book containing brief descriptions of practically all the recognised forms of friction clutches, specially those suitable for motor car work. It would have been better were the descriptions more lucid, but the line drawings used for the illustrations are good and set off this disadvantage. The relative merits of the various forms are discussed, and some hints on the proportioning of clutches are given.

Modern Practical Joinery. By George Ellis. Fifth edition. London: B. T. Batsford, Limited. 1924.—Mr. Ellis' book on joinery is so well known that it is almost unnecessary to say anything about it beyond that it is the standard English book on the subject. It first appeared in 1902, and successive editions have appeared from time to time, the last as recently as 1921. Since that date little revision has been called for, and whilst one or two chapters have been slightly modified, the present edition is, to all intents and purposes, the same as the fourth. A thoroughly practical work which no longer needs commendation.

Workshop Gauges and Measuring Appliances. By L. Burn. London: Sir Isaac Pitman and Sons. 1924. 5s. net.—A disappointing little book. Out of its 147 pages, 118 are devoted to cursory descriptions of all kinds of measuring appliances, with which every engineer is quite familiar—it is, in fact, little more than a catalogue. Towards the end there is a chapter on the selection and care of instruments, while the last chapter gives a brief outline of the principles of limits and fits. The measurement of screw threads is neglected entirely.

Cranes and Hoists. By H. Wilda. London: Scott, Greenwood and Son. 1925. 8s. net.—This book is a translation from the German, and is now in its second edition. In it there are given the essential particulars of almost every type of lifting tackle, from simple rope pulleys up to very large cranes, all in a very condensed form. Formulæ are given for the calculation of the dimensions of the parts of the machines. The book is illustrated by 399 line drawings and contains 155 pages.

BOOKS RECEIVED.

Radio: Beam and Broadcast. By A. H. Morse. London: Ernest Benn, Limited, 8, Bouverie-street, E.C. 4. Price 12s. 6d. net.

Untersuchungen über die Gas und öl-Gleichdruckturbine. By Wilh. Gentsch. Halle: Wilhelm Knapp. Price 5.20 marks.

Mechanical World Electrical Pocket Book, 1925. London: Emmott and Co., Limited, 20, Bedford-street, W.C. 2. Price 1s. 6d. net.

Das Rotorschiff und seine Physikalischen Grundlagen. By J. Ackeret. Göttingen: Vandenhoeck and Ruprecht. Price 1.80 mark.

Relativity and Common Sense. By F. M. Denton. London: Cambridge University Press, Fetter-lane, W.C. 2. Price 10s 6d. net.

A Text-book of Glass Technology. By F. W. Hodkin and A. Cousen. London: Constable and Co., 10–12, Orange-street, W.C. 2. Price 42s. net.

Regulation of Rivers Without Embankments. By F. A. Leete. London: Crosby Lockwood and Son, Stationers' Hall-court, Ludgate-hill. Price 30s. net.

Directory of Shipowners, Shipbuilders and Marine Engineers, 1925. London: The Directory Publishing Company, Limited, 33, Tothill-street, S.W. 1. Price 20s. net.

The Strength of Rotating Discs. By R. Gardner. London: The Association of Engineering and Shipbuilding Draughtsmen, 96, St. George's-square, S.W. 1. Price 2s. net.

The History of Munitions Supply in Canada, 1914–1918. By David Carnegie. London: Longmans, Green and Co., 39, Paternoster-row, E.C. 4. Price 18s. net.

Junior Technical Electricity. By R. W. Hutchinson. London: W. B. Clive, University Tutorial Press, Limited, High-street, New Oxford-street, W.C. Price 4s. 6d. net.

Instructions for Fitting Geysers. Compiled by the National Gas Council. Published by the British Commercial Gas Association, 28, Grosvenor-gardens, S.W. 1.

The Journal of the Institute of Metals, Vol. XXXII. Edited by G. Shaw Scott. London: The Institute of Metals, 36, Victoria-street, S.W. 1. Price 31s. 6d. net.

Directory of Contractors and Public Works Annual, 1925. Edited and compiled by C. W. Biggar. London: Wightman and Co., 104, Regency-street, S.W. 1. Price 15s. net.

Metallurgy and its Influence on Modern Progress. An address by Sir R. A. Hadfield. London: Chapman and Hall, Limited, 11, Henrietta-street, W.C. 2. Private circulation.

History of the Portland Cement Industry in the United States. By R. W. Lesley. Chicago: The International Trade Press, Inc., 53, West Jackson Boulevard. Price 3.50 dollars.

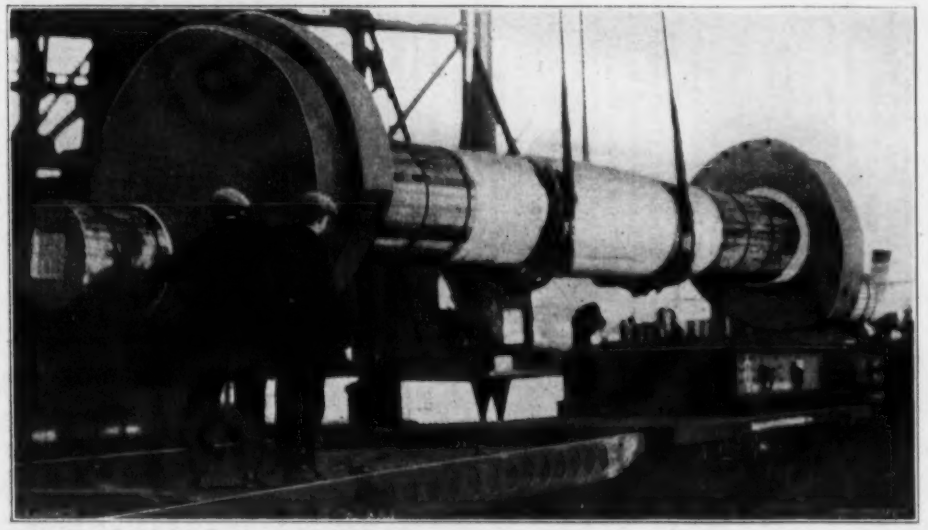
Foundry Practice for Draughtsmen. By M. Warnock. London: The Association of Engineering and Shipbuilding Draughtsmen, 96, St. George's-square, S.W. 1. Price 2s. net.

Aeronautics Catalogue of the Science Museum, South Kensington. Compiled by M. J. B. Davey. London: H.M. Stationery Office, Adastral House, Kingsway, W.C. 2. Price 1s. net.

PARTS OF 7150 B.H.P. BLAST FURNACE GAS ENGINE

SOC. ANON. JOHN COCKERILL, SERAING, ENGINEERS

(*For description see page* 168)



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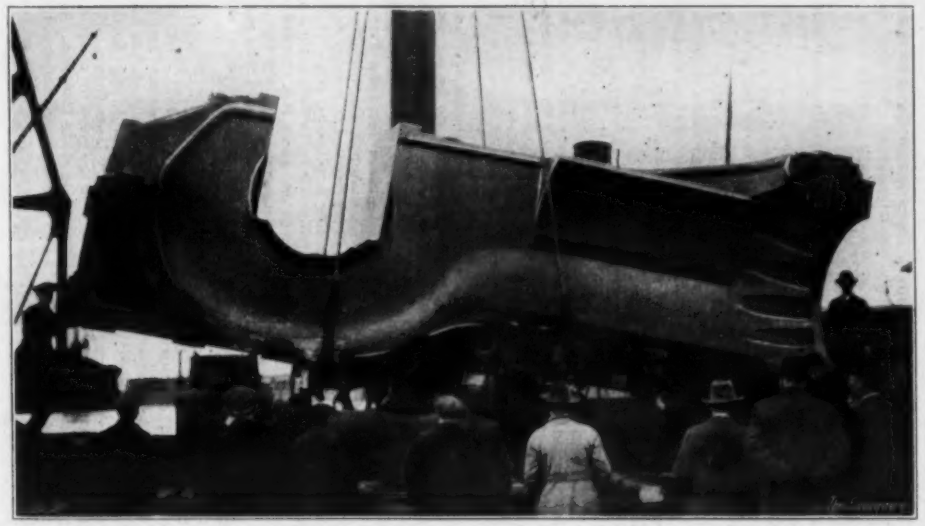
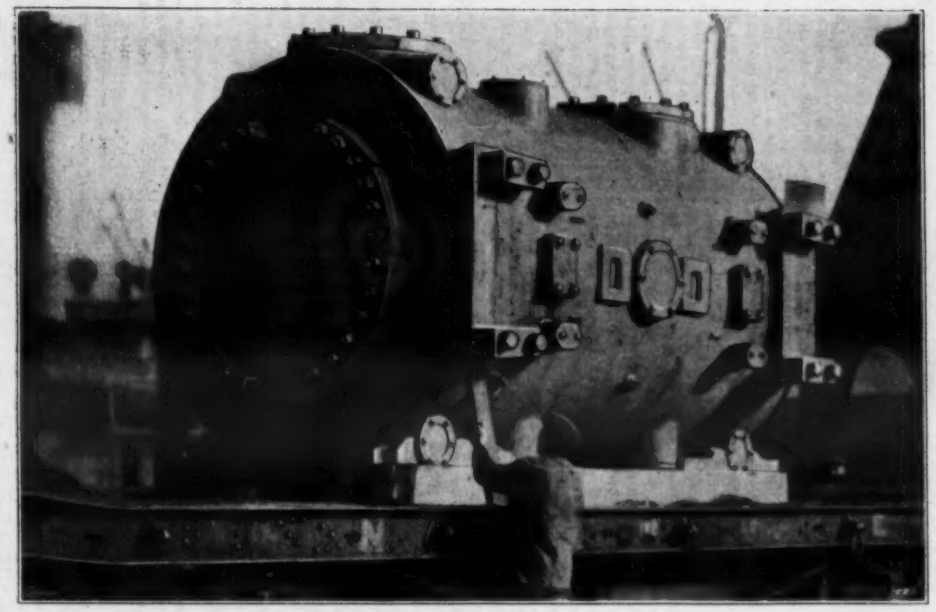
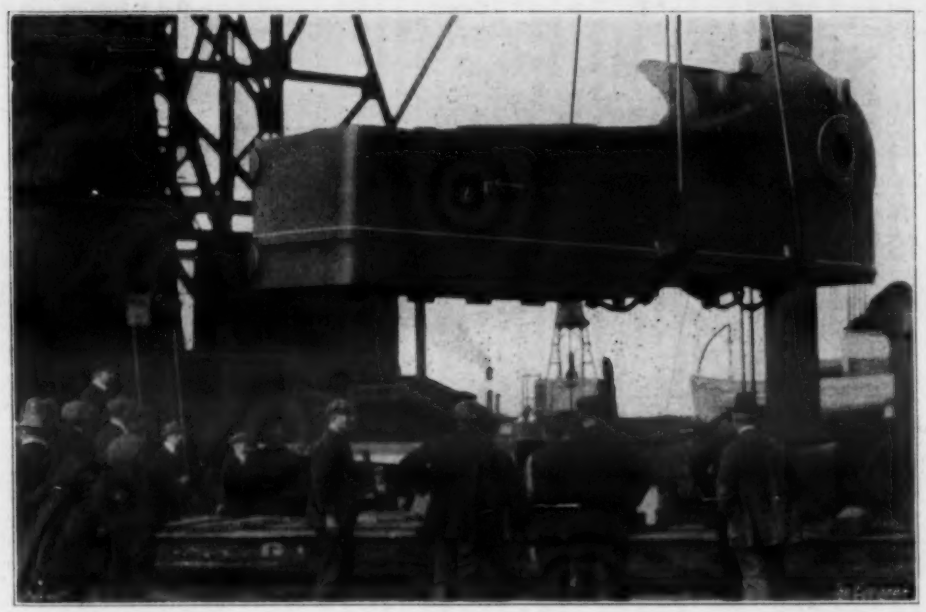


PART OF MAIN FRAME, WEIGHT 50 TONS



GAS CYLINDER, WEIGHT 30 TONS



PART OF MAIN FRAME, WEIGHT 25 TONS

High Head Pumping Plant for Simla Water Supply.

IN the annual article on Water Supply which appeared in our issue of January 23rd brief mention was made of an exceptionally high head pumping plant which was recently put into service at Simla. Situated as it is on the top of a ridge of hills which, in the dry season are practically waterless, Simla has always found its water supply a serious problem. Ever since Lord Dalhousie, in the early fifties, moved the seat of Government for a great part of each year to this station, and that migration was followed in 1865 by the transfer to it of the permanent Army Headquarters, its population and importance have steadily increased, and have made heavier and heavier demands on the available water supply. By the end of the war the three existing sources had become quite inadequate, and it was immediately apparent to a specially appointed Water Committee that an extensive new scheme must forthwith be put in hand. It therefore instructed Mr. A. F. Henderson, M. Inst. C.E., M.I. Mech. E., to devise a new water project, the first part of which has now been successfully carried out, as described below.

Some eight miles from the existing Simla reservoirs at Sanjouli, but about 4000ft. below them, is a permanent supply of available water in the Nauti River, a tributary of the Sutlej, to the former of which, it may be noted, the municipality is already indebted for its hydro-electric power. Mr. Henderson decided to avail himself of this source, and, having filtered the water by means of the Paterson rapid filtration process, to pump it in one lift from the village of Guma on the Nauti River to a high-level reservoir whence it might flow by gravity to its destination. The scheme, it should be mentioned, is being jointly financed by the Punjab Government and the Simla municipality, and on completion will be handed over to the latter for operation.

Tenders being called for, that of Turner, Hoare and Co., Limited, of Bombay, proved successful. That firm supplied not only the pumps and all the low-tension electrical gear, but also the rising main pipe lines, the piping from the delivery reservoir to an intermediate tank at Mashobra, and the main from that tank to the previously existing reservoir at Sanjouli, some two miles from Simla itself. The firm also undertook the cartage of all the material from Simla to the site, and the laying of the pipes. When it is realised that the material had to be taken down a zigzag road specially constructed for the purpose on the mountain side, and with an average gradient of 1 in 8, it will be understood that the operation was fraught with difficulty and danger; and it is with much regret that we have to record the death of Mr. C. F. Chute, B.Sc., Assoc. M. Inst. C.E., Messrs. Turner, Hoare's engineer in charge of the works, which was due to an accident in the conveying of the heavy machinery down the road.

SIMLA WATER SUPPLY—PUMPING STATION AT GUMA

Only two units out of the eventual six contemplated in the project, have as yet been installed. Each of them consists of an electrically-driven quadruple-acting pump made by Hathorn, Davey and Co., Limited, of Leeds, which is designed to lift 580 gallons per minute against a head from all causes of 4200ft. This is understood to be a record lift for a waterworks plant, and it will be noted from the subjoined record of the official tests that the overall efficiencies obtained are very remarkable, if they do not themselves constitute a record accomplishment. In this connection it will be of interest to note that, under the running conditions, the efficiencies of Nos. 1 and 2 motors, as determined by Metropolitan Vickers, Limited, which supplied them, from the usual tests in the shops, reached the remarkably good figures of 95.05 per cent. and 94.7 per cent. respectively. From those figures the net efficiencies of the pumps and gearing work out at 95.5 per cent. in the case of No. 1 pump and at 95.8 per cent. in the case of No. 2.

The pumps, of one of which we give a drawing in our Supplement, are of the four-ram type, the rams, which are of high carbon steel, being driven from two cranks at right angles to one another, giving four deliveries per revolution. The diameter of the rams is 5½in. and their stroke 3ft. All the packings are, of course, external and special patented stuffing-box lubricators are fitted. The ram cases, which are of mild steel, each contain two pump chambers arranged back to back, the outer rams being driven by means of side rods. The suction and delivery valve seats, which are of high carbon steel, are pressed into seatings in the ram cases themselves, there being for each ram six suction and two delivery valves, which are also of high carbon steel, and, as is usual for high heads, of the spring-loaded mitre type. Each pair of delivery valves works in one mild steel box, the cover of which is readily removable for inspection or adjustment, while each suction valve is also provided with a separate cover, the whole being remarkably simple and accessible. The drive is by means of double-helical gear, in one stage, jet lubricated, the pinion bearings, which are white-metal lined, being lubricated by oil under pressure. The power from the motors is transmitted by Wellman-Bibby flexible couplings.

The motors are rated at 1000 brake horse-power, though, as will be seen from the test results, that figure gives a very liberal power allowance, and is in that respect typical of the design of the plant throughout. They are of the induction type and run on a 50-period three-phase supply at 2200 volts. They are provided with liquid starters and with the usual rotor short-circuiting and brush-lifting devices. Messrs. Hathorn, Davey supplied, besides the pumps and motors, the necessary control panels, of the same make as the motors themselves, and fitted with the usual instruments and safety devices.

The rising mains, which are each some 11,000ft. long, are of solid-drawn mild steel, and are fitted at intervals with spring-loaded allevintors, also supplied by Messrs. Hathorn, Davey. They are so arranged that either pump can deliver through either or both mains, and provision is made for the insertion of the additional pumping and rising mains comprised in the complete scheme.

An extract from the engineer's reports on the two tests is given below, as is also a summary of results, and on neither, perhaps, is comment necessary.

"*Guma Scheme. Report on Test of Pump No. 2.*—In continuation of my letter dated 10th March, 1922, forwarding tenders in connection with the above scheme, I have now pleasure in stating that on August 15th, 1924, I carried out a six hour test on the first—No. 2—of the two electrically-driven high lift ram pumps installed.

"Each pump is designed to lift 580 gallons per minute when running at 48 revolutions per minute against a static head of 3939ft., through approximately 11,000ft. of mild steel piping, graduated in six stages, the external diameter of which is 7⅛in. throughout. In my report above mentioned you will notice that Turner, Hoare and Co., Limited, quoted for two different makes of pipes; the second (accepted) were slightly thinner and decreased the total head by approximately 3 per cent., which slightly diminished the total pumping head.

"The guarantee provides that when each unit is delivering 580 gallons per minute against a total head not exceeding 4337ft., the cost of electricity per 1000 gallons of water pumped into the delivery reservoir at Carignano shall not exceed 10.2 annas at ¼ anna per unit. A margin of 2½ per cent. to be allowed to cover errors in measurement if necessary.

"In this test the following methods were adopted for measuring the quantities involved, which were checked by other measurements as described:—

"(i) *Quantity.*—Measured at the delivery reservoir—Carignano—by means of a Fluxograph recording instrument supplied by the Paterson Engineering Co. (India), Limited, of Calcutta. Checks.—(*a*) For a limited period the fall in the suction tank was taken, allowance being made for gland leakage, &c., which was measured; (*b*) the rise in the water level of the delivery reservoir was accurately measured by float mechanism. This reservoir was found to be slightly absorbent, never having been filled to so great a depth previously. After all allowances were made, these tank readings confirmed those of the Fluxograph.

"(ii.) *Pressure Head.*—The static head was taken from the surveyed height, and the friction head, as measured by a certified Budenberg gauge, was added thereto. Check.—The reading of the certified gauge. Note.—In calculating the net head, allowance was made for the suction head—measured at the pumps by gauge—and also for the fall in barometric pressure—about 3ft.

"(iii.) *Power.*—This was measured on an integrating meter specially supplied for this test by the Metropolitan-Vickers Electrical Engineering Company, Limited, and re-tested and certified by the Calcutta Electrical Supply Company, Limited. It was placed at the commencement of Turner, Hoare and Co., Limited's contract on the 2200 volts motor circuit. Checks.—(*a*) Two integrating meters on the high-tension circuit; (*b*) Watt meter on high-tension circuit; (*c*) ammeter, voltmeter and power factor meter on high-tension circuit. Note.—In all the above high-tension circuit readings due allowances were made for transformer losses.

"Under the conditions of the contract, the pump improved on the guarantee—allowance having been made for the reduced friction head—by 12.2 per cent. The overall efficiency of motor and pump, computed as described above, is 90.75 per cent., and I consider that, in view of the rigid checks everywhere applied, this result may be taken as accurate within 1 per cent. The slip on the pump itself, reckoned as the difference between the quantity drawn from the suction tank and the actual ram displacement, was negligible. The overall efficiency on a displacement basis works out at 91.8 per cent.

"Throughout the test the plant ran very satisfactorily, and there was no excessive heating in the gears or bearings. The motor stood its tests as specified with great credit, and was very much within the guaranteed temperature rise on both the six-hour and the two-hour runs. The rising mains showed no sign of leakage and also stood their specified tests. I consider therefore that the installation is satisfactory, the efficiency obtained being better than I anticipated.

"From the above test the Municipal Committee will realise a saving of approximately Rs. 9000 per annum on this pump, which, capitalised over the loan period on the 6 per cent. basis, is approximately equal to Rs. 1,00,000. This is calculated on the following basis:—

One pump discharge equals	856,000 gallons per day of twenty-four hours
Approximate working of pump throughout one year	33 per cent.
Guaranteed cost per thousand gallons	10.2 annas (1)
Adjusted guarantee, allowing for diminution of friction head	9.85 annas (2)
Actual cost calculated from test	8.67 annas (3)

The above saving was calculated on Nos. (1) and (3) above.—(Signed) A. F. HENDERSON.

"*Guma Scheme. Report on Test of Pump No. 1.*—In further continuation of my letter dated March 10th, 1922, forwarding tenders in connection with the above scheme, and of my report dated August 16th on the tests of pump No. 2, I have pleasure in stating, that on September 15th, 1924, I carried out a six-hour test on the second—No. 1—of the two electrically-driven high-lift ram pumps installed.

"The corresponding overall efficiencies have been slightly improved as follows:—

	Per cent.
Overall efficiency measured on the quantity of water actually delivered at the high-level reservoir—	
First test (Pump No. 2)	90.75
Second test (Pump No. 1)	90.77
Overall efficiency on displacement basis—	
First test (Pump No. 2)	91.80
Second test (Pump No. 1)	92.00

"The cost per 1000 gallons actually delivered at the high level reservoir—Carignano—which was 8.65 annas per 1000 gallons, or 1.53 annas less than the guarantee, in the former test, is in this case practically the same. Both these improvements were, it must be remembered, made in spite of the allowance for the reduction in head due to the use of rising mains larger than originally contemplated.

"It is now noted for record that the saving in pumping charges on the basis of last report will be approximately Rs. 2,00,000 when capitalised over the loan period.

"In conclusion, I wish to state that I consider the test results eminently satisfactory, and that the municipality has obtained a plant with which it may justly be satisfied.

Signed, A. F. Henderson."

Summary of Tests.

	Test No. 2 pump.	Test No. 1 pump.
Date	Aug. 15th, 1924	Sep. 15th, 1924
Average speed, r.p.m.	48.66	48.73
Delivery head, feet	4178	4178
Actual measured delivery, gallons per minute	594.4	592.8
Displacement qu., gallons per minute	599.2	600
I.H.P.	829.25	826.5
	On actual delivery.	On actual delivery.
Water horse-power	752.6	750.4
Overall efficiency, per cent.	90.75	90.77
Motor efficiency is deduced from test at maker's works under running conditions, per cent.	94.7	95.05
Pump efficiency only	95.8	95.5

We give on page 162 two interior views of the pumping station and herewith a reproduction of a photograph looking down on the pumping station from rising ground above it.

Cheap Electricity.

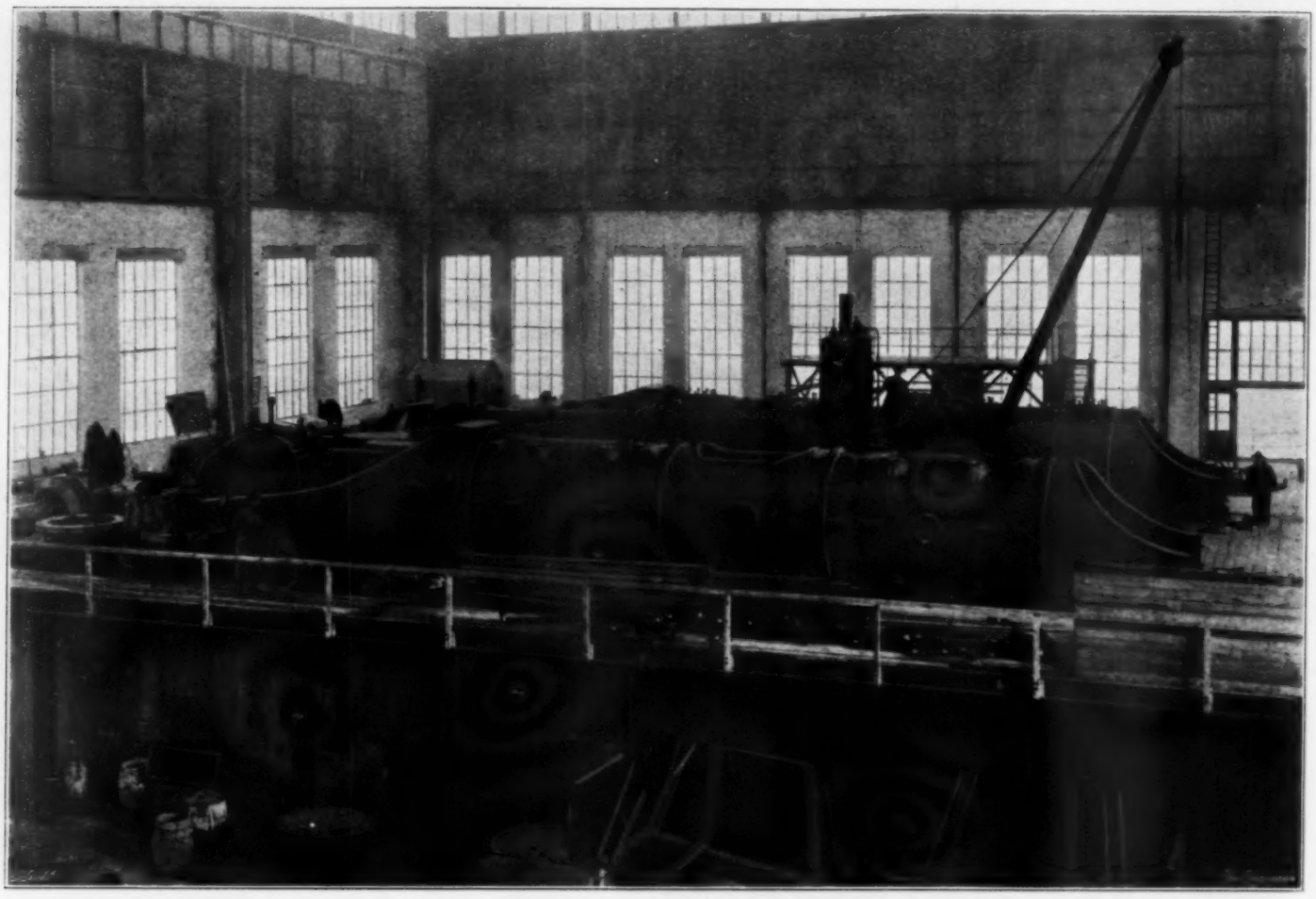
SPEAKING at the opening of the electricity station at Ringwood, Hampshire, on Friday, January 30th, Colonel Wilfrid Ashley said that if the age of electricity was to materialise there must be a cheap and abundant supply. Some imagined that this country was seriously handicapped by the lack of water power. It was to be remembered, however, that water power had one serious disadvantage. It was placed at the spot which Nature had decided, and that spot might be, and it generally was, far away from the centres of commercial and industrial enterprise, and much of the saving at the point of generation was absorbed in the expense of transmission.

England was admirably equipped for the production of electricity; no country, in fact, had better facilities. The country had plenty of coal, but water for cooling purposes was even more important than coal. After very careful consideration, the large stations that had been erected in the Clyde Valley and at Manchester had been erected in the vicinity of water, and not in the midst of neighbouring coalfields. The transmission of coal to the generating station and of electricity to the industrial areas was not a serious matter in a relatively small country like England.

As the pioneer work was done in England, the electricity supply undertakings had been on a small scale, and many of the best sites were still free from stations equipped with the best type of generating plant. If electricity generated in up-to-date stations were made available everywhere,

BLAST FURNACE GAS ENGINE IN COURSE OF ERECTION

SOC. ANON. JOHN COCKERILL, SERAING, ENGINEERS



there would be an appreciable improvement in the price of electricity. The prices charged for electric light must inevitably vary, but a common price was 1s. per unit; in fact, in some cases the prices had been as high as 1s. 6d. per unit. Against that, however, could be put the charge of 5d. per unit at Manchester, and a little over 4d. at Newcastle. The former case served as an example of what could be done by an undertaking in one large city, whilst the latter demonstrated the effect of spreading the supply over a wider area in the North-East Coast.

But those figures did not represent the final result. There were towns in Canada which were supplied with current for lighting at the rate of 1d. per unit. It was a little difficult to say whether it would be possible to get down to such a low figure in this country, but estimates for large modern stations showed that electricity could be supplied at cheaper rates than those in vogue at present. Before electricity could be made really cheap in this country its use would have to be extended. The quantity of electricity generated in public supply stations in Great Britain represented an average consumption per head of population of 110 units a year, but the same amount was probably produced in privately owed generating stations, so that the average consumption was probably about 200 units per head.

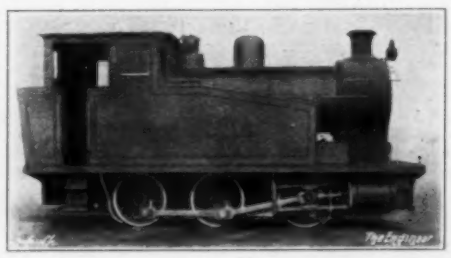
Compared with other countries, that figure was low. In the United States, the consumption as a whole was about 500 units per head, but the figure for the North-East States was as high as 800, whilst for California it was nearly 1200. Canada produced 900 units per head, Switzerland 700, Sweden and Norway about 500, and Tasmania 550. Even Shanghai had an output of 145 units per head of population. It was not to be imagined, however, that the work that had been done in Great Britain was insignificant. A sum of no less than £162,000,000 had been invested in the business, but as the pioneer work had been done in England, a number of small stations had been erected. There were in Great Britain 541 stations, which had to carry a large amount of spare plant as a protection against possible breakdown, and it was amazing to think that 68 per cent. of the total amount of plant in the public generating stations was standing idle. Since the war the output of the stations had increased, and it was still doing so. It had risen from 4¼ to 6½ thousand millions a year, an increase at the rate of 19 per cent. per annum.

There was ample room for improvement, but it was to be remembered that some of the uses to which electricity had been put in other countries were not so feasible here. Still, there was no reason why new districts should not be opened up and villages be given the advantages and amenities of electricity at a very much lower price than was possible under existing conditions. There was no reason why the best use should not be made of the country's facilities to produce cheap power for industry and traction, for heating and cooking, and for domestic purposes generally.

It was one of the main objects of the Ministry of Transport to see how far that very necessary and beneficial expansion could be brought about. Pending the wider possibilities foreshadowed, smaller developments were progressing. Since the Commissioners and Ministry were entrusted with the duty of administering the Electricity Acts—that was to say, during the last five years—applications for special orders to authorise undertakings had been coming forward in a stream, Ringwood's application being No. 132. That application had been granted, and it authorised a supply in the whole of the rural district, and it gave the company power to buy land for a generating station, and to lay mains in the necessary streets. It went even further, for it insisted that certain mains should be laid within two years, and it was to be hoped that the time was close at hand when the people of Ringwood would be enjoying the use of electricity for lighting, power and domestic purposes.

Narrow Gauge Locomotive for Assam.

THE little locomotive illustrated herewith is one of six built by Andrew Barclay, Sons and Co., Limited, of Kilmarnock, for the Assam Railways and Trading Company, Limited. It weighs 22½ tons empty and 28 tons in working order, and at 75 per cent. of the working pressure



develops a tractive effort of 12,380 lb. The wheels are 3ft. 2in. in diameter on a wheel base of 9ft. 6in., and the cylinders are 14in. by 22in. The boiler, which has been designed to comply with the Indian Boiler Regulations, is fitted with a copper fire-box and seamless steel tubes. It is built for a pressure of 160 lb. and has a heating surface of 567½ square feet. The safety valves are of the Ramsbottom type, and it will be observed that the lever is taken through into the cab so that the driver can ease the valves from time to time. Combination injectors of the builder's own make are fitted.

All wheels are braked and the brakes can be operated by hand or steam. The brake blocks, like the wheels, are made of semi-steel. The side tanks carry 670 gallons and the tops are cut away to improve the driver's view. Twenty-five hundredweight of coal can be carried in the bunker and, as will be seen, the cab is of good size.

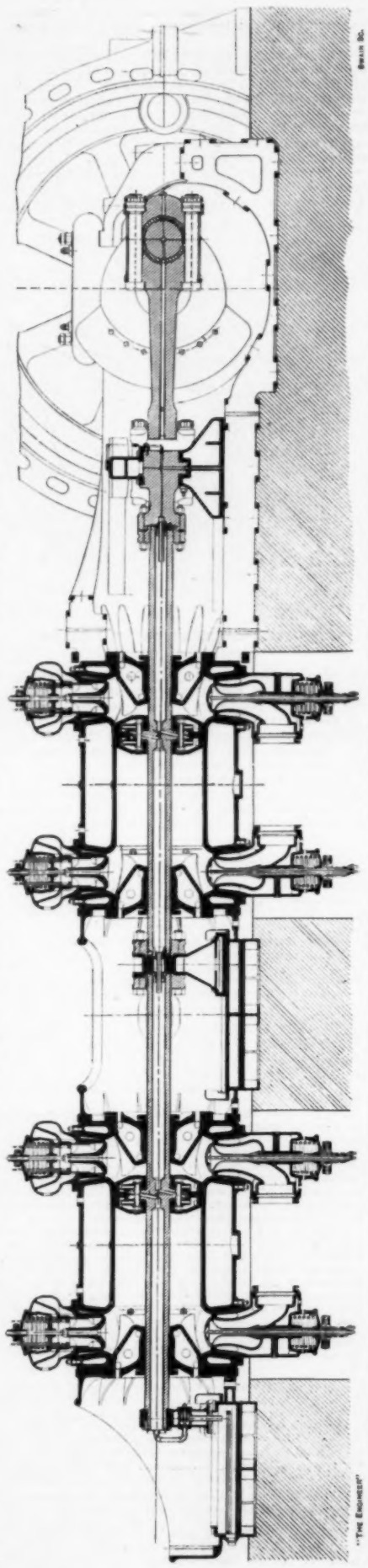
The gauge of the Assam railways is 3ft. 3½in. The engines have been built under the inspection of Robert Bruce and Son, London.

7150 B.H.P. Cockerill Gas Engine.

AT the present time there is being erected at the Devonshire Works of the Staveley Coal and Iron Company, Limited, Barrow Hill, Chesterfield, what will be the largest gas engine in this country. It has been built by the Société Anonyme John Cockerill, of Seraing, Belgium, and is of the four-cylinder twin-tandem type, with overhung cranks, operating on the four-cycle system. The diameter of the gas cylinders is 1.300 m. and the stroke of piston 1.500 m. The engine will be direct coupled to a three-phase fly-wheel alternator, of 5000 kilowatts, 6600 volts and 30 cycles, and will run at 90 revolutions per minute. The alternator has been built by the Ateliers de Constructions Electriques de Charleroi, Belgium. The power unit has been designed to run in parallel with existing turbo-alternators, and will operate on blast-furnace gas of a calorific value of about 100 B.Th.U. per cubic foot. The exhaust gases from the engines will be utilised in two Cockerill exhaust gas boilers, which will produce together 14,100 lb. of steam per hour superheated to 300 deg. Cent. at 160 lb. per square inch pressure. This steam will be passed into the existing works steam line. The weight of the total unit is approximately 1000 tons, the heaviest parts including main frames 75 tons each (each main frame being made up of two parts, weighing respectively 50 and 25 tons), crank shaft with counterweights 81 tons, alternator rotor 120 tons, and cylinders about 30 tons each. Views of some of the parts taken on their arrival at Hull are reproduced on page 166.

A description of a similar engine has already appeared in this paper in an article written by the late Professor Hubert, of Liége, on November 19th, 1920, but the engine which has been built for the Staveley Company embodies all the latest improvements of the Cockerill Company's practice. It is shown by a longitudinal section on page 169. The main frames, of which there are two, are cast in halves, one half in each case carrying the massive main bearing. They are assembled by means of shrunk steel hoops and rings, and the whole is securely bolted down to the foundation. The cylinders are of iron, cast in one piece, water-cooling spaces being provided between the inner and outer shells. Steel tie-bolts, fitted while hot, run through the water chambers from end to end, and ensure that the walls of the cylinders are in compression. At the front end of the front cylinders these tie-bolts form the connection

7150 B.H.P. COCKERILL BLAST FURNACE GAS ENGINE



to the main frames, and extensions of them run through the intermediate distance pieces and connect to the tie-bolts of the rear cylinders, the back end of the latter bolts forming the connection to the tail end guide. In this way an all-steel connection is ensured right from the main frame to the tail end guide. The intermediate distance pieces and tail end guides simply rest on well-lubricated base plates bolted to the foundation, and the engine is therefore free to move as it expands from the main frame back flange.

The cylinders have doors of large size to enable the water space to be cleaned out periodically. The inlet and outlet valve chambers are symmetrically arranged top and bottom at each end of the cylinders, and are of a slightly conical shape. The valve seats are recessed into these chambers almost as far as the bore of the cylinders; that is to say, as much as the valve lift will allow. The cylinder covers are hollow, and are given an ample water supply. Each of them is fitted with stuffing-boxes and glands complete with metallic packing, made up of special cast iron rings in three pieces, held together by an outer cast iron spring ring. Access to the interior of the cylinders can be had through the inlet valve chambers, which are sufficently large to allow of a man entering.

The body of the crank shaft is a solid ingot steel forging, as are the two crank webs and pins. The pistons are of cast iron in two halves, each of which butts up against a large steel collar forged integral with the rod, and is secured to it and to the other half by steel through-bolts. The collar is large enough to allow the assembling bolts to pass through and it really forms the piston proper, the two cast iron piston halves merely forming water circulation chambers and ring carriers. They also protect the piston proper from contact with the hot gases. The piston-rods are hollow bored, and the cooling water enters at the front end, passes through the two pistons and leaves at the back end, thus ensuring a definite circulation, with no possibility of short circuiting. The water is supplied under pressure by a combined trombone pump, which also forms the inlet water connection to the rods. The glands and stuffing-boxes of this trombone pump are quite accessible, and can be attended to whilst the engine is running. The connection of the piston-rods at the main and intermediate crossheads is made by bolted steel flanges screwed to the rods.

The exhaust valves are of forged steel hollow bored, and with hollow heads fitted with water circulation, the inlet and outlet being arranged through armoured hose. The exhaust valve chests and seats are also water cooled. The exhaust gas itself is dry, and is led through well-lagged cast steel pipes, free to expand and fitted with expansion boxes, to the exhaust gas boilers placed outside the engine-house. The valves themselves are positively opened by means of cams on the side shaft and closed by springs. The inlet valve gear is direct operated, the main valve being opened by a cam on the side shaft and closed by springs. This gear is substantially as illustrated and described in the article already mentioned of November 19th, 1920. Slight modifications have been made which enable the compression to be varied. A very careful valve setting results in a practically perfect scavenging of the products of combustion, and gives an indicated mean pressure in the gas cylinders of about 75 lb. per square inch, without an excessively high explosion pressure. The lubrication of the gas cylinders, metallic packing and exhaust valve spindle guides is effected by multiple pressure feed pumps, operated from the side shafts. Each point is lubricated by a separate piston, and the flow can be seen and adjusted whilst the engine is running. The main bearings, big and little end bushes and main cross-head shoes are lubricated by pressure feed. The oil is delivered by four pumps placed in the foundation, two of which are capable of pumping all the oil required, the remaining two being always available as spares. The oil is drawn from a reservoir, to which it is returned after use; there it is filtered and passed through an oil cooler. The ignition is produced by high-tension magnetos, one magneto being fitted for each plug, of which there are two at each end of each cylinder. Each magneto can be advanced or retarded as desired whilst the engine is running. The ignition therefore is entirely independent of any outside source of current. The starting of the engine is carried out by compressed air, at a pressure of 150 lb. per square inch. By means of a compressed air valve fitted to the electric barring gear and operated by the lever which throws the pinion into gear with the rotor rack, all the starting valves are held open during barring, thus releasing the compression. An automatic valve makes it impossible to admit live compressed air to the cylinders for starting until the barring gear is out of gear.

At a later date, after the plant is running, we hope to publish a full description of the power station, gas-cleaning plant and the auxiliaries.

RIBBLE NAVIGATION.

THE waterway leading through the estuary of the river Ribble up to the port of Preston, 15 miles inland, is being deepened by dredging in the upper reaches and directed by the construction of training walls at the sea end. Since dredging operations were resumed after the Armistice, the length of 8 miles of upper reaches was deepened 5in. in 1919, 6in. in 1920, 7in. in 1921, 8in. in 1922, 10in. in 1923, and 6in. in 1924; in all, a total deepening of 3ft. 6in. The seaward end requires no dredging, as the tides directed by the training walls maintain and improve that length of the river.

The shallowest place in the upper reaches varied in 1924 from 1ft. 8in. to 4ft. 4in.—the average being 2ft. 11in.—above sea low-water level, and on an ordinary spring tide, which rises to 27ft. above sea low water, there are depths of 23ft. to 25ft., admitting vessels of 23ft. draught to the dock. The pre-war volume of imports and exports has been exceeded. During last year further equipment has been added. A new coal hoist, capable of lifting a 23-ton wagon 50ft. above the quay, and two 30-cwt. level luffing cranes, having a rake of 60ft. and a lift 75ft. above the quay at this radius, were supplied and erected by Armstrong, Whitworth and Co., Limited. A new power-house has also been erected, 5 miles were added to the sidings, additions were made to the china clay sheds, and wood pulp storage sheds, cattle lairage, and additional roads and new repair workshops were constructed, for the purpose of keeping abreast of the needs of the growing trade of the port.

A NEW TEE SQUARE.

AN application of magnetic properties which, when mentioned, seems very obvious, but has not, we believe, been successfully utilised before, is the maintenance of a T square against the edge of a drawing board. The idea has, however, been developed by Axene, Limited, of Maxwell House, Arundel-street, Strand, and from what we can see promises to become very popular in drawing-offices.

With ordinary carbon steel as the material for the magnet, such a scheme could not be carried out with any degree of permanence, but the advent of cobalt alloy steel has enabled magnets of real permanence and comparatively light weight to be produced, and this is the metal used for the heads of its T squares by the Axene company. The head is a simple casting, to which the blade is fixed either by a couple of screws or a swivel joint, and is very little, if anything, heavier than a wooden head. The casting is magnetised with a pole at either end in the case of the smaller sizes, or with an extra central pole for larger heads. The reason for the extra pole is to provide a grip when the T square is used near the bottom of the drawing board, and a large part of the head consequently protrudes below the end of the steel strip set in the edge of the board, in the place of the usual ebony, to which the magnet is attracted.

The strip is ground straight and true, so as to provide an intimate contact with the face of the magnet, and is fixed in a slot in the edge of the board by a few brass screws. It will be readily appreciated that existing drawing boards can easily be adapted to the new idea. It is also possible to fit a metal strip along the lower edge of the board, for vertical ruling, but in such cases it is best to have an adjustable swivelling blade to the T square to allow for changes in the shape of the board.

The grip provided by the magnet is quite sufficient to hold the T square steady enough for all ordinary drawing purposes, but makes no appreciable difference in the effort necessary to slide it up and down the board, while it is strong enough to hold the square up when working along the bottom of the board. The consequent convenience in leaving the left-hand free for the manipulation of drawing instruments or set squares needs no emphasis.

In view of the proved permanence of the magnetic qualities of cobalt steel, which has already been referred to in THE ENGINEER, and the negative results of some rough treatment to which we subjected the head of one of these T squares, it appears that they should retain their grip on the board almost indefinitely.

Another simple, yet effective, patented feature of these instruments is the bevelling of the lower edges of the blades, so that they ride over drawing pins without catching.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE D.P. BATTERY COMPANY, Limited, Bakewell, Derbyshire, has appointed Messrs. Kelsall and Parsons, 19, Blythswood-square, Glasgow, as its agents for Scotland, in place of Mr. William Scott, who has reliquished the agency, which he had held for many years.

THE MORGAN ENGINEERING COMPANY, Alliance, Ohio, announces the appointment of the following district representatives:—Mr. C. O. Cromwell, 2230, First National Bank Building, Detroit, Michigan; Mr. F. E. Bausch, 1105, Chemical Building, St. Louis, Mo.; Mr. Duncan A. MacLeod, 918, Ellicott-square, Buffalo, N.Y.; Mr. R. R. Glover, 2310, Union Central Building, Cincinnati, Ohio; W. R. McDonough and Co., First National Bank Building, Cleveland, Ohio; McMullen Machinery Company, 64, Ionia-avenue, Grand Rapids, Michigan; Millholland Sales and Engineering Company, 225, Indiana Terminal Warehouse Building, Indianapolis, Indiana; C. B. Davis Engineering Company, Brown-Marx Building, Birmingham, Alabama; P. I. Perkins Company, 110, High-street, Boston, Massachusetts; Stewart H. Ford, Mutual Building, Richmond, Virginia; Dravo-Doyle Company, Schaff Building, Philadelphia, Penns.

THE INSTITUTE OF METALS.—The latest half-yearly issue of the *Journal* of the Institute of Metals, Vol. XXXII., contains two special lectures as well as fourteen papers presented at the recent London meeting of the Institute. Dr. F. W. Aston's May lecture on "Atoms and Isotopes" will be read with interest. As an instance of the latent power within the atom Dr. Aston states that if the hydrogen in a tumbler of water could be transformed into helium the liberated atomic energy would be sufficient to take the Mauretania across the Atlantic and back at full speed. The autumn lecture, delivered by a distinguished American metallurgist, Mr. W. M. Corse, of Washington, D.C., is of an essentially practical character, dealing with "Recent Developments in Non-ferrous Metallurgy in the United States." In the discourse special attention is paid to nickel and aluminium-bronze and to the casting of metal in "long-life" moulds. A casting machine is described that will produce 2000 castings in five hours with unskilled labour. These lectures and papers cover nearly 500 pages, the remainder of the volume being devoted to abstracts of papers dealing with non-ferrous metals and alloys. There are upwards of 1000 of these abstracts covering a wide field.

THE BASLE EXHIBITION OF 1926.—The International Exhibition for Inland Navigation and Utilisation of Hydraulic Power, which is to be held in Basle in 1926, is intended to present an idea of the development and present progress of navigation on inland waterways in various countries and the utilisation of these waterways for power production. The idea of combining inland navigation and the utilisation of hydraulic power in one and the same exhibition arose from the consideration that the adaption of natural waterways to inland navigation is very often only possible by the construction of dams with locks. But the construction of such dams can only be justified on economic grounds if they, in addition to assisting navigation, can be utilised for the production of power. In order to provide as complete a picture as possible of the utilisation of hydraulic power, the exhibition is not intended to be restricted to river power plants (low-pressure plants) only, but will also take into consideration high-pressure plants. It is intended to stimulate popular interest in navigation on inland waterways and their utilisation for power production and to visualise for the public authorities and the people in general the great economic importance which attaches to inland navigation and the utilisation of hydraulic power. It will be open from July 1st to September 15th.

An Automatic Air-compressing Plant.

WE recently had an opportunity of inspecting a new electrically-driven automatic air-compressing plant, which has been installed in the crypt of the House of Commons by the Hamworthy Engineering Company, Limited, of Poole, Dorset, and 76, Victoria-street, Westminster, London, S.W. 1. The plant replaces earlier steam-driven compressors, and the air is used for the operation of three sets of Shone ejectors which are required to raise sewage through a height of about 12ft. from the drains in the House of Commons to the London County Council street sewers.

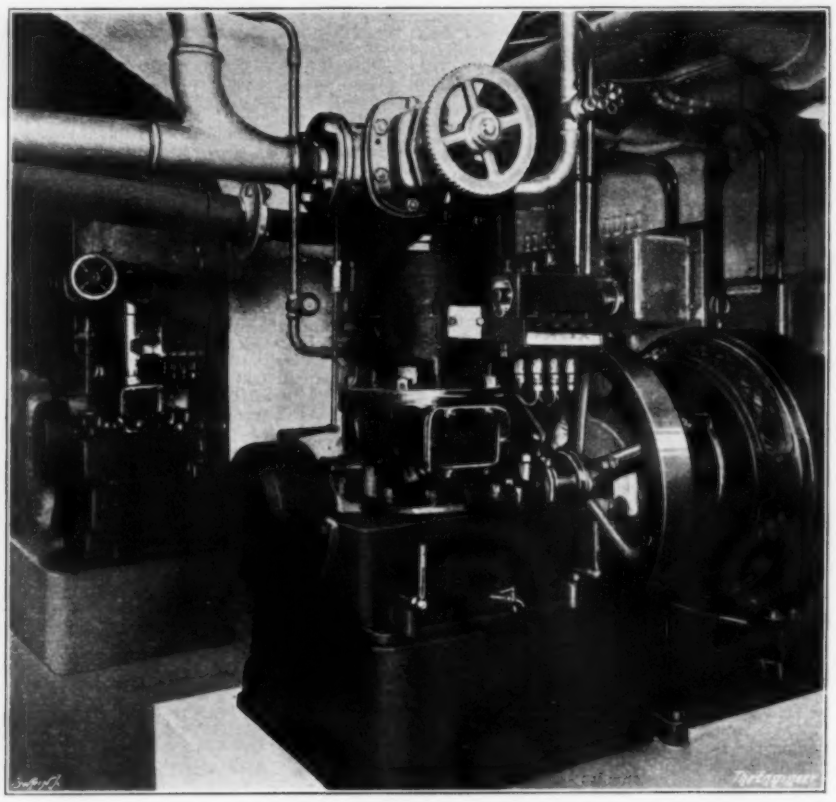


FIG. 1—INTERIOR OF COMPRESSOR ROOM IN THE CRYPT AT THE HOUSE OF COMMONS

Two sets of compressors are used, each of which comprises a standard Hamworthy single-cylinder unit with a cylinder bore of 10in. and a piston stroke of 7½in. Each machine is designed for an output of 170 cubic feet of free air per minute at a pressure of 40 lb. per square inch when running at a normal speed of 500 revolutions per minute.

The two compressors are shown in Fig. 1, and in drawing—Fig. 2—some details of construction are given. The machines are driven by 25 brake horse-power motors, made by Crompton and Co., Limited, of Chelmsford. They operate on a 400-volt supply main circuit, and the automatic self-starting controls were made by the Igranic Electric Company, Limited, of Bedford, and 149, Queen Victoria-street, London.

The compressor and its motor are mounted on a cast iron stool, and the drive is transmitted by a leather-link type of flexible coupling.

Referring to Fig. 2, it will be seen that the compressor is substantially constructed, and is fitted with ring lubricated main bearings of considerable length. The crank shaft is provided with balance weights, and the bottom end connecting-rod bearing is lubricated by means of a banjo oiler plate supplied from a mechanically-operated lubricator fitted at the front of the cylinder casing. This lubricator also delivers oil to two non-return connections for cylinder lubrication. The piston pin is hollow for part of its length, and one end of it is fitted with a spring-controlled oil-scraping ring, by means of which additional oil is given to the top end connecting-rod bearing. A flat topped piston is employed, which gives a minimum clearance space, and it is provided with four piston rings at the top and one scraping ring near the bottom of the piston skirt. The cylinder casing is in one casting complete with its water jackets. It registers into the short crank case and gives support to the piston for practically its whole length. It may be noted that a large inspection door is provided at the front of the crank case which gives access to the moving parts.

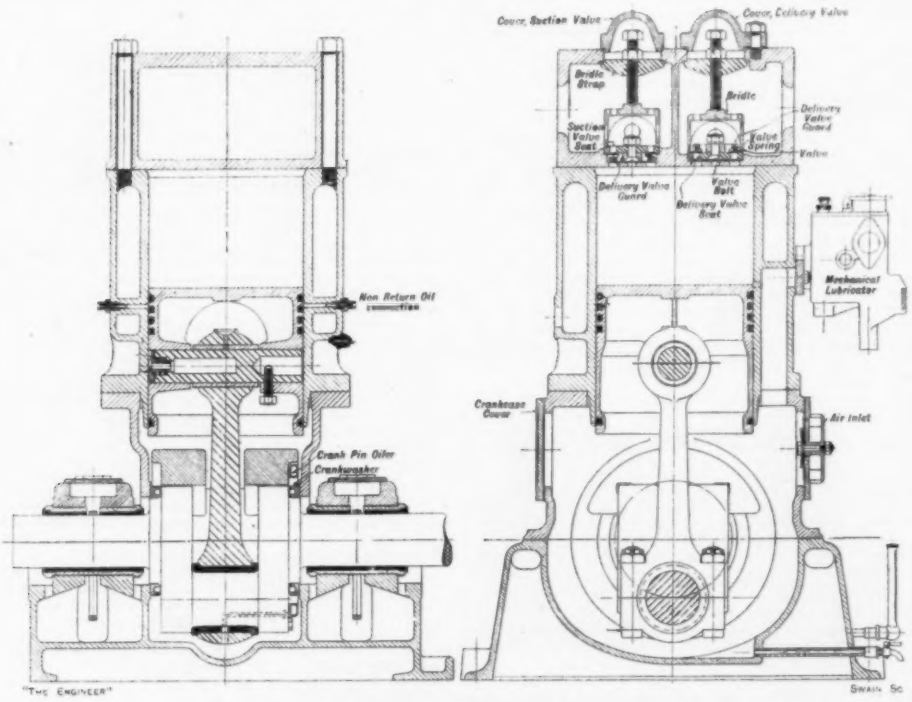


FIG. 2—SECTIONS THROUGH HAMWORTHY AIR COMPRESSOR

The view given to the right of Fig. 2 shows the plate-type of suction and delivery valve which is used. There are three suction valves and two delivery valves to each cylinder, and one of the suction valves is automatically controlled by the centrifugal enclosed crank shaft governor—shown in Fig. 1. When the compressor is stopped the controlled suction valve is held in open position by the back gear, and as soon as the compressor gains speed the valve is released and is allowed to work in the normal manner. Easy starting at all times is thus effected. The compressors we saw were well finished, and they were complete with air and cooling water control valves, water and oil drains and two oil well gauges fitted to the bed-plate sump.

When in operation the plant is designed to start up automatically as soon as the pressure of air at the Shone ejectors falls to 12 lb. per square inch. The compressors then run until the air storage tank is charged to a pressure of about 40 lb., which allows the Shone ejectors to operate frequently before the compressor comes into operation again, which is clearly illustrated by the recording pressure gauge diagram reproduced in Fig. 3. This was taken on a fine day, and it may be remarked that the frequency of operation is much more pronounced in wet weather. The rising curve of the diagram represents the charging period, while the stepped line of the falling curve shows the discharge period, each step representing one operation of the ejectors. Normally the compressors run for about 20 minutes with intervals of rest varying from three-quarters to two hours before the next charge is necessary, the time depending upon the volume of rain water or sewage which has to be dealt with.

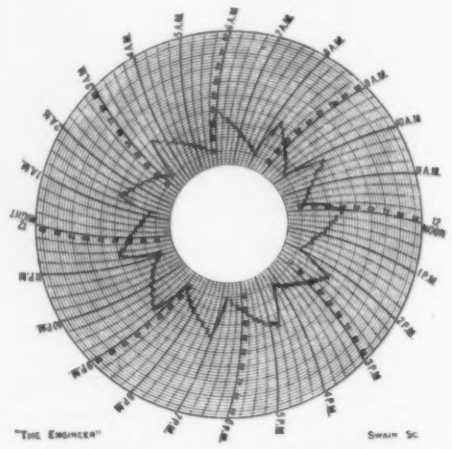


FIG. 3—PRESSURE GAUGE DIAGRAM

We were impressed by the comparatively silent running of the machines and the quick way in which they were automatically run up to speed and shut down after the required pressure in the storage tank was obtained.

HEMATITE IRON ORE STANDARD.

HEADQUARTERS of the British Chemical Standard movement announce that, following the original programme set forth in 1916, they have now reached the stage when they are able to issue the first of a new series of standards, viz., iron ore "A" (hematite type) having the following standardised figures:—

Sample Dried at 100 to 110 deg. Cent.

Iron	58.19 (0.12 per cent. insoluble)
Phosphorus	0.056
Silica	8.14
Sulphur	0.066

In due course a complete analysis of the standard will be reported.

The standard has been specially prepared to meet the need for a widely recognised sample for checking analyses of cargoes of iron ores by chemists representing buyers and sellers, and for standardising volumetric solutions, such as pot. di-chromate, &c. As usual, the analysis has been conducted by a number of qualified independent analysts, works and mineowners' chemists, &c. (fourteen in all), who have had special experience in this class of work and who represent the different interests involved in the wholesale merchandising of iron ores.

Bottles of the finely ground standard material may be obtained from Headquarters, 3, Wilson-street, Middlesbrough, at a fee estimated to be sufficient to cover the cost of preparation. The three usual sizes are provided, viz., 500 gramme, 100 gramme, and 50 gramme. A certificate giving the names of the analysts collaborating, together with full notes on the methods employed, and a detailed list of individual analyses will be supplied with each bottle.

ROYAL INSTITUTION.—A general meeting of the members of the Royal Institution was held on Monday, February 2nd, Sir James Crichton-Browne, treasurer and vice-president, in the chair. The special thanks of the members were returned to Captain H. Loeffler, M.R.I., for his generous gift of a collection of valuable electrical apparatus. Miss M. S. Bailey, Mrs. Claude Bartholomew, Mrs. Charles Johnston, Miss G. Mocatta, Mr. H. W. Quelch, and Lieut.-Colonel J. V. Savage were elected members.

INSTITUTION OF NAVAL ARCHITECTS.—The annual meetings of the Institution of Naval Architects will take place on Wednesday, April 1st, and the two following days, in the Lecture Hall of the Royal Society of Arts, John-street, Adelphi, W.C. 2. The Duke of Northumberland, the president, will occupy the chair. The annual dinner will take place on Wednesday, April 1st, at 7.30 p.m., in the Grand Hall, Connaught Rooms, Great Queen-street, Kingsway, W.C. A gold medal will be awarded by the Council to any person, not being a member or associate member of Council, who shall at the forthcoming meetings read a paper which, in the judgment of the Council, is deemed to be of exceptional merit. The Council will also offer a premium of books or instruments to the reader of any paper, not being a member or associate member of Council, which paper, in the judgment of the Council, merits this distinction.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Trade Conditions.

THE iron and steel trade in the Midlands and Staffordshire continues rather discouraging, with an absence of large buying. The slow recovery of trade is causing disappointment, the optimistic forecasts of the beginning of the year not having, so far, been justified. Not only has the first month's trading disappointed expectations, but anything like scale buying is no more visible now than it has been since the turn of the year. While throughout Midland trade circles a spirit of optimism still prevails, in many local industries new orders have not come to hand so freely as was anticipated. Consequently demand for material remains small and irregular. Users of iron and steel calculate that by giving out only the minimum amount of orders to cover immediate needs they will be free to take advantage of the lowest level of prices which the reaction threatens to enforce. Already their efforts to secure lower prices are meeting with some success, blast-furnacemen this week giving way to the extent of 6d. to 1s. per ton, and billet makers have again returned to the £7 basis for mild steel billets.

Midland Iron Workers' Wages.

Midland ironworkers' wages, which are regulated by the sliding scale under the Midland Iron and Steel Wages Board, will remain unaltered from Monday, February 9th, to Saturday, April 4th. The previous bi-monthly ascertainment had a similar result. Puddlers' wages at date are 67½ per cent. above the basis rate of 13s. 6d.

Engineering.

The Midland engineering industry shows progress. Constructional engineers, although well employed, are still urgently in need of further orders, but both electrical and mechanical engineers are busy. Employment in the engineering iron foundries is well maintained, and the house building activity is keeping makers of light castings well supplied with orders. A steady flow of business is recorded by the leading makers of cast iron and wrought iron pipes. The position in the edge-tool trade is steadily improving, while all sections of the hollowware trade are well employed. In spite of increased German competition, makers of agricultural and horticultural implements state that early orders to hand are of greater volume than was the case a year ago. Machine tool makers are still benefiting from the highly satisfactory position of the motor and cycle trade, and considerable orders for the renewal and extension of plants are now being executed. Work in the motor engineering shops is very satisfactory, and there are signs of an exceptionally busy season. Several leading firms already report a rush of orders in excess of those to hand at the end of January last.

More Work.

Additional orders have come to Midland works, many firms figuring in the latest list of contracts for supplies given out by Government departments. These include orders for electrical plant and accessories, steel shafting, and nickel-plated spoons for the Admiralty, motor cycles, pneumatic tires and oil stoves for the War Office and aeroplane spares for the Air Ministry.

£76,000 Bridge Tender.

A tender of just over £76,000 for the reconstruction and widening of the English Bridge and approaches at Shrewsbury, by Muirhead, Macdonal, Wilson and Co., of London and Birmingham, is to be recommended for acceptance to the Shropshire County Council and the Shrewsbury Town Council.

Advice to Metallurgical Students.

Mr. Gilbert C. Vyle, when addressing the University of Birmingham Metallurgical Society last week, emphasised that in many ways there were developments of commercial application to which metallurgists might turn their attention. In spite of the wonderful progress that had been made, there was a very wide field for the metallurgist of to-day and to-morrow. Malleable castings, said Mr. Vyle, were made to-day as they were 200 years ago, when the process was introduced. Need that be so? It was a long-time process. Could it not be shortened? Foundry work had altered little from its early days, and only in mechanical details. The methods of melting, mixing, pattern-making, and the use of sand were all the same. There was room for enormous economies. When was the metallurgist going to show them how to die cast at high speed ordinary iron, brass, and steel?

Staffordshire Bar Iron.

The orders for Staffordshire iron are small, warehouses having now satisfied their requirements for the present. No change has been made in quotations. Transactions for medium and common bars are of the most meagre dimensions. Staffordshire ironworks have increasingly to depend upon re-rolling steel orders, for which, to some extent, foreign material is employed. Large wagon-building contracts have been a useful windfall in this direction, but with the present wide disparity of price between iron and steel and the increasing utility of steel for welding purposes, the iron manufacturers are very badly handicapped in competition. Marked bar makers, however, have little to complain of. The ascendancy of steel tells against South Staffordshire. Rolled into sheets drawn into tubes formed into sections, and applied in all sorts of ways, steel has usurped the place of iron in many important fields. The enhanced values of to-day make the conditions all the more unequal. Where the difference of price in pre-war days was £1, it is now nearer £2. Makers of wrought iron claim that an analysis of cost in relation to durability would show that the advantage is still with them, notwithstanding the ingenuity which has been shown in protecting tubes and other steel products against corrosion. This is a matter so vital to the South Staffordshire trade that judgment ought not to be allowed to go by default. Mills which used to be employed in rolling native iron are now putting the finishing touches on imported semis.

Steel Values.

Midland consumers of steel are content to buy for current needs, being satisfied that higher prices are very improbable. At present the tendency is slightly in the other direction. Joists, nominally £9 5s., can be bought at £9 and even £8 17s. 6d., specifications being so scarce that makers are ready with concessions to get business. New orders given out for immediate requirements show some increase, a decidedly encouraging feature. The position is no better as regards half products. After a temporary bracing up the billet trade is giving ground again. Soft billets can be bought from Welsh producers at £7, but other steel works quote £7 5s. up to £7 10s. Belgian billets range from £6 5s. to £6 10s. The demand is not there however. Bargaining is very restricted, there being but a very limited demand. Small steel bars can be readily obtained at £9, and steel strip at £9 10s. to £10, according to size. The demand for bedstead angles has improved a little, but rather more tonnage is received from Belgium. The demands of the tube works are not so good as they were. Rather more inquiry for constructional steel is in the market, and there is a disposition among municipalities to place in hand orders for steel pipes, gasholders and other large plants, which are considered overdue. Widespread dissatisfaction exists among constructional engineers owing to the addition of 10s. to the quotation for constructional steel plates by North-Eastern steel works where delivery has to be given in the Midlands. As the engineer on the coast can buy at £9 5s. against £9 15s. here, Midland builders of steel find themselves time after time beaten in competition, especially in bridge-building contracts. Some strong representations are likely to be made to the steel manufacturers on the subject. The freight from the North of England costs about 15s., and it is understood that the steel makers consider some of this ought to be paid by their customers. Foreign steel is not quite so pressing as it was, but there are still heavy deliveries coming in on old contracts.

Sheets.

The galvanised sheet trade is fairly busy, though prices are slightly weaker. Many mills have this week accepted £17 2s. 6d. for 24-gauge sheets, and £17 5s. is the general quotation. There are a few firms who quote up to £17 10s., but very little, if any, business is done at this figure.

Scrap.

While heavy wrought iron scrap is in good demand at about £4 12s. 6d. delivered, steel scrap is in slackened demand. Deliveries to South Wales are undertaken at £4 and to Sheffield at about £3 17s. 6d.

Cheaper Pig Iron.

The pig iron department continues dull, but Midland furnaces appear to be disposing of their production, though occasionally they have to shade prices. As a matter of fact, furnacemen are slowly but surely succumbing to the pressure of events. There is more pig iron on offer than the market wants, and producers who will not accept lower prices do not get the business. Last week's lowest quotations have now become the maximum, and business is done at 6d. to 1s. 6d. lower than producers would hear of a week ago. Northamptonshire forge sells at £3 10s. 6d., No. 3 foundry £3 15s. 6d., Derbyshire forge £3 16s. 6d., No. 3 foundry £4 2s. at furnaces. Foundry qualities continue to be practically the only sorts called for, forge material being something of a drug on the market.

Unemployment.

A decrease of nearly 4000 in the number of unemployed in the Midlands area is shown by the latest returns. The current total is 150,963, as compared with 154,647 a week ago. The figures give the following totals:—Men, 102,125; boys, 3334; women, 40,798; girls, 4706. The returns for the principal towns are:—Birmingham area, 32,037; Bilston, 2824; Coventry, 1704; Cradley Heath, 5664; Derby, 2170; Dudley, 4387; Leamington and Warwick, 584; Leicester, 4557; Northampton, 8939; Oldbury, 1748; Peterborough, 630; Redditch, 1323; Smethwick, 4968; Stoke-on-Trent area, 14,886; Stourbridge and Brierley Hill, 4663; Tipton, 2264; Walsall, 7531; West Bromwich, 3444; Wolverhampton, 5608; and Worcester, 2260.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Conditions.

THE markets in Lancashire are indicating further weakness in iron and metal prices, and the generally optimistic feeling of the earlier part of January seems to have vanished. It is very difficult to find any real change in the business situation as between the beginning and the end of last month, but there is an immense difference in business feeling. One does not know how to account for this change in any logical manner, but possibly there is some rather exaggerated reaction from an unduly optimistic view of the position. Apparently, the optimists had not taken into consideration the immense difficulties in the way of reducing British manufacturing expenses to any reasonable level, compared with manufacturing costs in other parts of the world. This is a problem to which the most serious attention should be paid, for upon it depends our place in the industrial world.

Metals.

All the non-ferrous metals have been going through a period of reaction lately, and it is difficult to say how far this movement may go before a corresponding upward movement is again inaugurated. So far as copper is concerned, one cannot expect any very serious setback in prices, because the metal has long been practically at pre-war figures, and, of course, the costs of production, in this as in every other case, are very much heavier than they were before the war. There seems therefore to be a definite limit to any fall in copper prices, say, of £2 or £3 per ton; but, of course, this is not the case with regard to the other non-ferrous metals. The weakness in copper is perhaps caused by the temporary withdrawal of European buying, more particularly in Germany. The reports of a considerable quantity of second-hand metal in that country are vague, but they probably have some effect in inducing the consumer to withhold orders for a time. In the Lancashire district there is not so much inclination to buy this week, and an idea is prevalent that the consumer need not hurry to cover requirements. Figures are published showing that the world production of copper in 1924 was larger than it has ever been, the total being given as 1,458,737 tons, or more than 100,000 tons in excess of the previous year. Certainly, the consumption needs to grow if it is to keep pace with this tremendous output. The manufacturing engineer in this country cannot be expected to regret that German competition in manufactured copper is increasing. If serious competition comes from other manufacturing countries, there may be some hope that the British makers' prices may at last be modified. The mechanical engineer in Manchester does not forget that while he is made to pay £95 for ordinary strong sheets, the price of 4ft. by 4ft. copper braziers for India is £84 10s. per ton. Tin is recovering from the recent setback, and there seems to be more confidence here in the future of this market. The weak speculators have been shaken out, and, as far as can be seen, the way is prepared for a further advance. The sharp fall in the price of lead was not altogether unexpected, although it was rather more than people anticipated, and may easily lead to reaction. Some arrangement has been reached by the British and Belgian manufacturers of sheets and pipes to mitigate competition in the British market, but the Belgians are still entitled to sell here at £3 per ton below British prices. Of course, the British manufacturing margin in pipes and sheets was excessive. Spelter has suffered to a certain extent in sympathy with lead.

Pig Iron.

The market in Manchester for foundry pig iron is very quiet and barely steady. Although the stronger sellers of No. 3 Derbyshire iron are asking 90s., it has been possible lately to obtain a concession of 1s. or perhaps 1s. 6d. per ton. Many of the orders coming on the market now are for small quantities, and for these it may not be worth while to take less than 90s., but it is clear that the feeling in the market is weaker, and consumers are the more encouraged to keep back orders as long as possible. It is, no doubt, the weakness in the Cleveland market which is now encouraging the Manchester consumer to look for lower prices for the Midland irons. The difficulty of the ironmasters there is that their output requires a substantial export demand to prevent accumulations, and just now continental consumers can do better with their own makers of pig iron. It seems quite probable that if the dearth of foreign orders for Cleveland iron continues, makers in that district must seek to extend their home market; and in that case they will naturally turn to so important a consuming centre as Manchester. It is true that lower prices for pig iron will not allow of a living profit, but it may be better to accept them than to blow out more furnaces. Scotch iron is thought to be easier here again, although no definite change is reported. East Coast hematite is comparatively cheap at 98s. 6d. to 99s. delivered in Manchester. In the market for manufactured material things are much as they were. No doubt there is weakness here also, but one is not sure that it is any more pronounced this week than it was last week. The nominal prices are still at £9 per ton for joists and angles and £9 15s. for plates and round bar steel, and if there be any difference it is to be found in the amount of the concessions which can be obtained for prompt and favourable specifications. One cannot find that there is yet any increase in the volume of the demand for manufactured steel, and this is really what is wanted to bring the market back to a healthy condition. For Lancashire bar iron at £12 10s. per ton there is only a poor demand, and it is to be feared that the encroachments of Belgian iron are getting more serious.

Scrap.

The foregoing paragraph will, of course, show why the demand for heavy wrought scrap is not so good as it was. Some dealers here come down to 85s. delivered for this class of scrap, as against 90s. asked and given not so long ago. Heavy steel melting scrap is also very much neglected, and it is difficult to find any satisfactory market for it. Lancashire dealers are no longer buying at 70s. on trucks, and probably 65s. is now the utmost that would be given. The weakness in pig iron is, of course, not without effect on the market for cast scrap here. Holders of textile cast scrap still ask 87s. 6d. to 90s. per ton delivered; but for ordinary good foundry scrap from 82s. 6d. to 85s. is a fairly full figure now.

The Engineers' Club, Manchester.

It is good to see members of the engineering profession taking an active part in the public life of our great centres of industry. Actuated, no doubt, by this thought, the members of the Engineers' Club, Manchester, on Thursday, January 29th, entertained five of their number who have recently achieved distinction. They were:—Alderman F. J. West, the Lord Mayor of Manchester, who is the head of the well-known firm of gasworks engineers; Alderman G. Billington, the Mayor of Salford, who is a sanitary engineer as well as chairman of the Electricity Committee of the "Royal Borough"; Sir Benjamin Longbottom, who is

managing director of Electromotors, Limited, chairman of the Beama, and chairman of the engineering section of the Manchester Chamber of Commerce; Mr. E. A. Radford, Member of Parliament for South Salford, who is by profession an accountant, but is also financially interested in an engineering firm; and Mr. A. E. Grundy, Mayor of Dukinfield. The President of the Club, Mr. John Taylor, occupied the chair on what he described as a unique occasion in the history of the Club. He said he was sitting in a "mayor's nest," in proposing the health of the guests, and the guests replied in terms suitable to the happy occasion, the Lord Mayor's speech being particularly appropriate to the occasion. The Mayor of Salford spoke of the high standing of the men who had filled the position of chief electrical engineer of the borough—Mr. C. E. Taite, Mr. J. A. Robertson and Mr. Watson—all of whom are members of the Club. All the speeches were of high quality, and the evening was voted a great success. In the course of the proceedings the hon. secretary, in the absence of the Chairman (Mr. J. B. L. Meek), announced that the President, Mr. John Taylor, had presented his holding of 500 shares in the Club Company, which owns the premises, to the trustees of the Club.

Superheat and Superheaters.

A paper with this title was read at a meeting of the Manchester Association of Engineers at the Engineers' Club on Friday, January 30th, the author being Mr. J. R. Hannan (Swansea). He could not understand why the original obstacles to the employment of superheated steam—faulty lubricants and lack of provision for expansion and contraction of the metals—should be allowed to influence engineers and steam users of the present day and cause the luke-warm reception which superheaters still received. He then proceeded to enumerate the well-known qualities of superheated steam, and the advantages obtainable by its use. As an instance he mentioned the ordinary steam locomotive in which the resultant saving might be as high as 35 per cent., depending upon the design. He said the maximum economies would arise by the use of steam superheated to a total of 600 deg. Fah. in compound engines, and that, generally speaking, the majority of engines were quite suitable for steam superheated to a total of 500 deg. Fah.

The Longitudinal Strength of Ships.

In a paper read before the Liverpool Engineering Society on Wednesday, the 4th inst., Mr. E. F. Spanner, M. Inst. N.A., reviewed briefly some of the principal factors of which account is taken in strength calculations. He pointed out that the designer is faced with the fact that beyond a certain point the results of calculations have no real quantitative meaning. They are all comparative, and the only actual records in existence of stresses developed in ship structures at sea indicate that the calculated stresses are appreciably in excess of those which are observed. He considered it very unsatisfactory that only one series of experiments should have been carried out on a vessel at sea since the initial conception of a scientific method of dealing with longitudinal strength calculations. Having been responsible for the inspection of many vessels of different classes, many of which were over ten years old, he had come to the definite conclusion that the existing ideas on longitudinal strength calculations needed revising, and he believed that the actual stresses which are brought upon the structure of a vessel at sea are appreciably less than are provided against.

Liverpool Engineering Society.

The annual dinner of this Liverpool Society was held on Thursday, 29th ult., at the Midland Adelphi Hotel, and was presided over by Mr. R. E. Gibson, M. Inst. C.E., the President. There were about 230 members and guests present. The toast "The Engineering Profession" was proposed by Mr. J. Sandeyman Allen, who referred to the proposal to construct a new wide road to carry the traffic of the great industrial area round Liverpool, and to the scheme for constructing a tunnel under the Mersey to connect the Lancashire and Cheshire sides of the river. These schemes were necessary to the success of Liverpool as a port. Mr. Allen said that 45 per cent. of the machinery exports of this country were sent from the port of Liverpool. In his reply, the President, who is a gas engineer by profession, laid stress on the need for the scientific and economical treatment of the country's coal, which, he said, was being recklessly wasted. The High Sheriff of Lancashire (Mr. A. M. Lamb) proposed "The City of Liverpool," which was responded to by the Lord Mayor. The toast "Our Guests" was proposed by Mr. J. Reney Smith, M. Inst. C.E., who said that there was a feeling of optimism with regard to the future of the engineering industry, but that the revival could only be brought about by the close co-operation of the employers and workers. He pleaded for mutual confidence and sympathy, and on the men's part he said that there should be an appreciation of the difficulties of carrying on industries overburdened with taxation. Higher wages and restricted output could only hasten the time when the works must be closed. Mr. Patchell, President of the Institution of Mechanical Engineers, replied to the toast, and made special reference to the marine oil engine trials which the Institution, in conjunction with the Institution of Naval Architects, was conducting. He said that they were grateful to Liverpool, and especially to Messrs. Alfred Holt and Co., for the assistance given to the Committee in connection with these trials, and made an appeal for a further £500 towards the expenses. Mr. Patchell announced that this summer the Institution of Mechanical Engineers would celebrate the Stephenson centenary at its meeting at Newcastle-upon-Tyne.

BARROW-IN-FURNESS.

Hematite.

The condition of the hematite pig iron trade is unaltered, and during the past week there has been no development whatever, for the better at any rate. Many buyers are holding off, being content simply to order for their immediate requirements, while others are placing orders for delivery ahead—but not very far ahead. It has been suggested that the quietness is due to the fear of coal trouble, but it is difficult to way whether that be so or not. The shipbuilding trade has not been booking many orders of late, and that is bound to have its effect upon the pig iron trade. There is no lack of confidence, but there are some who expected trade to have made more forward moves than it has. The continental trade is dull, but there are still deliveries to America. A part cargo left Barrow last week for Philadelphia, and there was also a part cargo of pig iron for Bombay. The latter is the first for some time.

Iron Ore.

The iron ore trade continues the same, with the biggest proportion being used in the district. Scottish smelters are taking some ore each week to the extent of a thousand tons or so. The prospect is not bad, and better trade is generally expected. The trade in Spanish and North African ore is steady, and regular deliveries are being made in this district.

Steel.

The steel trade has orders which will keep it going for a month or two. The Workington Mills have work to take them into March, including that on rails, sleepers and fish-plates. The Barrow rail mills will be kept going for a time with orders held. The small section and hoop mills at Barrow are kept going regularly. Foundries are pretty well employed. Fuel is in fair demand.

SHEFFIELD.

(From our own Correspondent.)

Heavy Steel Trade.

CONDITIONS in the basic side of the steel industry show no improvement. Not only has the hoped-for New Year revival not materialised, but there has actually been a falling off of business, and the depression to-day is as acute as at any time during the latter half of last year. Orders for billets are confined to odd lots, and there has been a decline in inquiries, while a good many instructions have been sent out to reduce or suspend deliveries of pig iron, billets, scrap and coke. The market for steel scrap is easier. As pointed out last week, the acid side of the trade is in a better position than the basic, and is benefiting largely from the good volume of orders from the railway companies.

The Lighter Side.

Conditions in the crucible steel and tool branches are uneven, but on the whole they are much better than those of the heavy side. Quite a good demand for the better qualities of steel is being experienced by a good many works, and there are signs of expansion, but in other cases a substantial falling off in inquiries and orders has to be reported. The purchases of general stores by local works were better last month than in any month of 1924, which is a cheering feature, and seems to indicate greater aggregate activity. There is an improvement in the crucible steel trade, in which more furnaces are working than was the case last year, and a good sign of the times is that at present there is no quotation for scrap for pot melting. The prevailing feeling is still optimistic, but it cannot be denied that the confidence is not so strong as it was. The number of men in receipt of unemployment benefit in the city is as large as it was in January last year, and fully a thousand of those who were suspended at Christmas have not yet returned to work. That a large volume of trade is being done in the city is shown by the fact that about 160,000 persons are contributing to the insurance fund, but, on the other hand, there are 24,000 out of work, which proves that Sheffield has still a long way to go before it regains full prosperity.

Cutlery and Plate.

The total value of the cutlery exported from this country last year was £1,030,461, as compared with £636,129 in 1913, the last year before the war. Although this represents a substantial advance in money value, it does not follow that the quantity shipped was greater, as nearly the whole of the cutlery exported was of the stainless variety, which did not exist in 1913, and which costs nearly twice as much as the ordinary kind. The value of the imports of cutlery was much the same as in 1923, less than in 1922, but considerably more than the pre-war rate, the figures being:—1924, £474,849; 1923, £479,559; 1922, £548,226; 1913, £153,940. There has so far only been a partial beginning of the New Year trade in plate and cutlery. Firms, the trade of which is largely done through ordinary shopkeeping channels, have very little work on hand, and the outlook in this respect is not at all good. Large special orders continue to be booked however. Very little is being done in ordinary razors.

Trade Name Protection.

Sheffield has such a high reputation for the quality of its products that the name of the city on any article is a valuable asset. This has, as might be expected, led to abuse, and there exists in the city an Advisory Committee, associated with the Cutlers' Company, which performs excellent work in protecting this trade name against piracy. During the past year the Committee has achieved a remarkable success in obtaining the registration of the word "Sheffield" as a community mark for various classes of goods, under the Trade Marks Acts. The Committee's annual report states that "this is the first occasion on which the name of a place has been registered in England as a community mark, and it is satisfactory to report that the registration has already been of considerable assistance in suppressing the improper use of the name of Sheffield."

Colliery Developments.

The preparations for the opening up of the great coalfield in North Nottinghamshire are making much headway, and a striking vision of the future activity of the district and its transformation from a rural to an industrial area is presented. The Bolsover Colliery Company has practically completed a large colliery at Clipstone, and it is sinking another at Cockglode, between Ollerton and Edwinstowe, while the Butterley Company has one in hand at Ollerton, where it has reached a depth of 800ft. in No. 1 shaft. The Wigan and Stanton companies are also engaged in the development of the area. Mr. H. E. Mitton, managing director of the Butterley Company, speaking at an officials' gathering at Ollerton on Saturday, expressed the opinion that within the next fifteen years these various developments would result in from 15,000 to 18,000 tons of coal being brought to the surface daily.

Railways in Sherwood Forest.

That all these activities will call for the provision of large transport facilities is obvious, and the railway companies concerned are making active preparations to meet the need. The proposals in this direction are at present raising an outcry on the part of those who desire to see the amenities of the celebrated Sherwood Forest preserved. The agitation refers specially to a scheme of the London, Midland and Scottish Railway Company, which proposes, by its new Bill, to take powers for the construction of 22 miles of line in Nottinghamshire, including a branch from Ollerton to the Cockglode Colliery. The plans for the colliery itself include provisions for the protection of the beauty of the woodland area, as the pit is to be worked entirely by electricity, which will be brought to the site by cable. The railway proposal, however, involves the construction of an embankment from 20ft. to 30ft. high, and the laying of a line through the Beech Avenue, known as "the Cathedral of the Forest." The London and North-Eastern branch is on the other side of the colliery and does not touch the Beech Avenue or any other part of the charming forest scenery. Protests against the schemes are being led by Earl Manvers and taken up by the Regional Town Planning Committee of Mansfield and District; efforts are being made to enlist the co-operation of Sheffield, Nottingham and other large cities and towns; and it is proposed to promote a petition for presentation to Parliament. Mr. Mitton, in the speech referred to, said that while they were all anxious to preserve the amenities of the district as far as possible, they must have adequate railway transport. He suggested that the various parties concerned should get together and thoroughly discuss the matter. Another suggestion put forward is that a joint line might be constructed to cope with the output.

Other Developments.

In connection with the development of Thorne Colliery, near Doncaster, progress in which was reported last week, it is now announced that contracts have been let for a screening plant to Messrs. Plowright, Chesterfield; ventilating fan, the Waddle Engineering Company, Llanelly; and an air compressor, Messrs. Belliss and Morcom. A large sump, 40 yards deep, has been sunk below the Barnsley seam in No. 1 shaft. The Staveley Coal and Iron Company is about to increase its capital to £4,000,000 by the creation of 1,000,000 additional ordinary shares of £1 each, 463,773 of which are to be issued and offered to shareholders. The money is wanted to provide capital and pay for various extensions to the works. The Bullcroft Miners' Welfare Committee has erected a fine hall, costing £7000, at Carcroft, near Doncaster, and this was opened last Saturday by Mr. W. Humble, a director of the Markham group of collieries.

A Gift to Chesterfield.

Chesterfield Corporation has received a gift, of much engineering interest, in the shape of the mansion known as Tapton House, and 200 acres of land. The donor is Mr. Charles Markham, chairman of the Staveley Coal and Iron Company, Limited. The house was formerly the residence of George Stephenson, who lived there during the time that he was carrying out many important schemes in the district.

NORTH OF ENGLAND.

(From our own Correspondent.)

Hopes Unrealised.

THE confident hopes expressed at the opening of the year that the iron and steel trade would experience a considerable impetus are still unrealised. Certainly the year opened on a confident note, and it is a fact so far as the pig iron trade is concerned that the total tonnage of iron sold under forward contracts reached a high figure. Indeed, so much iron was sold that four additional blast-furnaces were put into operation. But the wisdom of this step is already being questioned. The rush for supplies has ceased, and so difficult has it become to find a market for the output that at Seaton Carew one blast-furnace is being laid idle. Still, there is no disposition to take a pessimistic view of the outlook. The decline in the home demand for iron can only be temporary. The real weakness of the position is to be found in the fact that the export trade is still dwindling, the shipments from the Cleveland district to foreign ports having gradually dropped since October last until last month they reached the very small total of 13,227 tons. It is all a question of price. Cleveland iron is too dear for European consumers to buy, even though ironmasters have cut quotations until the standard quality at 79s. per ton is now at the lowest price which has been touched for nine years.

Sudan Development Scheme.

Details are now available of great engineering projects in the Sudan which will, incidentally, bring considerable work to the North of England. The work includes the erection of a huge steel bridge over the White Nile, the reconstruction of the tramway systems at Khartoum and Omdurman, and the erection of water-works systems at both places. The firms concerned in

this enterprise are Dorman, Long and Co., Limited, Callender's Cable and Construction Company, Limited, the English Electric Company, Limited, and the Prudential Assurance Company, Limited, a company having been registered by the group. The principal item is the construction of the bridge to link up Khartoum and Omdurman. The bridge will consist of eight through spans of 240ft. and a swing span of 240ft., giving two clear openings of 100ft. each. The total length of the bridge, with approach embankments, will be 3466ft., and when completed it will have a 30ft. road, which will take a single-line tramway. The steel work of the bridge will be fabricated entirely at Middlesbrough, and will be sent out to Khartoum ready for erection. Other work includes the extension of the existing power station plant and installation of a distribution system for the supply of electric lighting and power in Khartoum, Khartoum North, and Omdurman, and a waterworks distribution system.

Iron and Steel Exports.

The shipments of pig iron from the Cleveland district during January totalled 31,186 tons, of which 13,227 tons went to foreign ports and 17,959 coastwise, as compared with a total of 27,805 tons in December. Germany took over 2000 tons of pig iron, and 2781 tons shipped to Denmark was quite exceptional. On the other hand, only 147 tons went to Belgium, compared with an average of about 4500 tons per month last year, and 730 tons shipped to France was no more than a third of last year's average. The United States with 3445 tons ranked as Cleveland's best customer last month, and it is not improbable, in view of conditions across the Atlantic, that this may continue. The shipments of manufactured iron and steel amounted to 52,749 tons in January, compared with 52,101 tons in December. There was a drop of 639 tons in the foreign shipments, but the coastwise quantities were up 1187 tons.

Cleveland Iron Market.

The Cleveland pig iron market still presents a quiet tone. The recent decline in prices appears to have scared buyers off the market, and they are now waiting until the downward movement has ceased before placing further orders. That stage has probably now been reached. At all events, though new business is restricted, makers are inclined to adopt a firmer attitude. They are resisting attempts to cut prices further, and realised figures are rather higher than they were. The big drawback is the continued lack of export business, but there is now little difference between Cleveland and continental prices, and this being so, some improvement in this direction should speedily accrue. No. 1 Cleveland foundry iron is steady at 84s.; No. 3, 79s.; No. 4 foundry, 78s.; and No. 4 forge, 77s. per ton.

Hematite Pig Iron.

There is little change in the position in the East Coast hematite pig iron trade. There is a fair demand both on home and export account, but there is keen competition, and although mixed numbers are generally quoted at 86s. 6d. and No. 1 at 87s. per ton, a good order could be placed at 6d. per ton less.

Ironmaking Materials.

The foreign ore trade is lifeless. Consumers a e well stocked, and only odd cargoes are being taken up, contracting over a period being in abeyance. Best Rubio ore is nominal at 22s. 6d. per ton c.i.f. Tees. The demand for furnace coke is improving and sellers of good Durham furnace qualities quote 24s. to 24s. 6d. per ton delivered at the works.

Manufactured Iron and Steel.

A marked decline is reported in the inquiry for manufactured iron and steel, and it is thought that the fall in pig iron prices has created an expectation of easier steel prices also. Manufacturers, however, declare that these anticipations are doomed to disappointment owing to the high cost of production. At all events, there is no weakening in prices yet.

The Coal Trade.

There is very little development in the Northern coal trade. The position, however, is no worse, but, if anything, a little brighter than at the close of last month. The steam small coal trade shows signs of increasing briskness. Danish buyers have bought substantial quantities for shipment over the ensuing three months, and some large orders have been placed from other countries, including orders from Bombay. Prompt prices are unchanged, but for forward the position is better. Steam coals are fairly steady for prompt, but although inquiry ahead is good, actual bookings are slow. Du.ham gas coals are quiet just now, but coking unscreened shows signs of a revival in demand. The position in the coke trade is quiet and irregular, as some makers, after a quiet time, have received substantial orders, which tend to clear the market of large quantities; but at the same time there are still many holders pressing on the market. The tone, however, is steadier, and late prices are unaltered.

SCOTLAND.

(From our own Correspondent.)

Clyde Shipbuilding.

FROM launching statistics reported the shipbuilding industry on the Clyde would appear to be in a fairly satisfactory position, but various circumstances are apparent which materially alter the outlook. Costs of construction have increased slightly of late, while the applications for increased wages from different sections of workers cannot be ignored, or, at least, the effect on probable contracts must be taken into account. Consequently it is not to be wondered at that fresh inquiries are far from numerous, and that builders are not able to submit tenders sufficiently low to satisfy owners. Furthermore, the position of the freight market is not calculated to stimulate the demand for new tonnage. During the month of January eight vessels of 28,566 tons aggregate were launched from Clyde yards, chief of which were as follows:—Chitral, twin-screw, 15,200 tons, for the P. and O. S. N. Company, London; Alynbank, twin-screw motor ship, 5200 tons, for the Bank Line—Messrs. Andrew Weir and Co.—Glasgow; Sir Thomas Price, twin-screw hopper dredger, 1600 tons, for the Union Government of South Africa. Only a small number of fresh contracts have been reported since the beginning of the year, and are as follows:—A large cargo steamer, for Messrs David McIver and Co., of Liverpool; a crane-carrying steamer—for a crane of 80 tons capacity—for New Zealand owners; sand suction dredging plant for service at Gambia; and two small pleasure yachts.

Steel.

New business in steel is exceedingly light, and there is a less optimistic spirit in the market. Some makers are confident, however, that better conditions are not far off, and a slackening in continental competition is anticipated in view of discontent expressed at higher prices and protracted deliveries. In some instances local works have already benefited to some extent where prompt delivery has been essential. Shipbuilding demands continue below normal, but a better request is reported for structural material. Steel sheets are busy on export account, while inquiries, both on export and home account, are numerous. The demand for galvanised varieties is very brisk, and prices are likely to firm up.

Iron.

The bar iron works are not particularly well placed, makers having practically overtaken the orders which accumulated during the New Year holidays, while new business is as scarce as ever. The business secured in connection with railway contracts has been disappointing so far, and local demands are far below normal. Owing to the scarcity of orders for iron material the mills are chiefly engaged in manufacturing steel bars from foreign billets. There is no improvement in pig iron. Consumers are still taking deliveries of contracts arranged before the end of December last, and fresh business is difficult to secure. Export demands are few and far between. Prices are unchanged.

Coal.

There is no sign of an abatement of the acute depression in the coal trade and prices still tend downwards. German competition in foreign markets is still very keen, and the effect on home collieries, especially in the East of Scotland, is most marked. The time is fast approaching when a further curtailment of outputs will be necessary. Experience has taught that it is better to keep collieries going at a loss than to close down, and probably that fact has prevented many concerns from suspending operations, but there must be a limit beyond which a loss is unbearable. Almost the only exception to the general stagnation is to be found in the case of prime splints, which have been well booked ahead for the Mediterranean and the river Plate. Lothian and Fifeshire steams have been a shade busier, but orders have not been sufficiently large to affect the turnover to any extent. Washed nuts continue in a most unsatisfactory position, and are likely to weaken further in price. Aggregate shipments for the past week amounted to 85,410 tons, against 84,729 tons in the preceding week and 97,018 tons in the same week last year. In the home market conditions are slow, only best brands of household coal showing any particular activity. Prices of best household fuel have been advanced by 2s. per ton.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

THERE has not been a great deal of change in the conditions governing the steam coal trade since I wrote a week ago. It is doubtful, however, whether the position is quite as good, for the supply of ready tonnage is unequal to the demands, and many collieries are compelled to exercise a certain amount of pressure upon their contractors to lift the coals which they have bought. Exporters have experienced considerable difficulty in finding an outlet for the coals they hold, and have accepted recently very low prices in their efforts to make business. As a result the position of many of them is not an envious one, in view of the fact that for the Mediterranean, and particularly Italian ports, the freight market has gone against them, and unless rates of freight come back the prospects are that a number of firms will come out on the wrong side financially. The position is that the homeward markets have been better of late, with the result that many owners have sent their steamers out in ballast. Steamers are going farther afield, with the inevitable consequence that the available supply of tonnage for the Mediterranean ports—that is, of steamers of 4000 to 6000 tons—is for the moment at any rate unequal to requirements. Whereas ten days or so ago the market for West Italy was round about 9s., owners are now asking 9s. 9d. to 10s., and the difference is quite sufficient to turn a possible small profit into a loss. The scarcity of tonnage is reacting upon a number of the collieries, which have difficulty in maintaining regular work at the pits. Fresh inquiry coming forward from abroad is on comparatively small lines and is still mainly for single cargoes.

Suggested Bonus to Coal Consumers.

All concerned in the steam coal trade have been much interested in a speech which was made on Saturday last at the annual banquet of the Bristol Channel District Association of Chartered Shipbrokers by Sir John Beynon, who is a well-known coalowner and a past chairman of the Coalowners' Association. Naturally, Sir John dealt with the state of the coal trade, and, referring to the fact that they were on the eve of arranging a new wages agreement with the miners, he pleaded that a little less suspicion and a little more good will should enter into the negotiations which the colliery owners are about to undertake. He remarked upon the unfortunate fact that the South Wales coalfield could no longer command the markets of the world, and said that if it was impossible to reduce prices they were faced with the problem of how to regain their status in the world's markets. He threw out the suggestion that the Government should grant a bonus, not to the coal trade, but to every consumer of coal, and that the bonus should be 2s. 6d. per ton and that the price of coal should be established at somewhere round about the average price for last year. He believed that if that course were adopted there would be a natural expansion of trade. Referring to the steel trade in particular, he pointed out that as it took approximately 4 tons of coal to turn out a ton of semi-finished steel from the iron ore, his scheme would mean a bounty of 10s. per ton in the price of steel, which would enable the steel trade of the country to meet foreign competition. He expressed the opinion that the carrying out of his suggestion would entail a cost which would be more than compensated for by the reduction in the enormous amount of money being spent by this country in the payment of doles. Sir John Beynon did not go more into detail, and, of course, many interested in the trade have been reluctant to express their views on the suggestion in the absence of having more facts and figures before them. At the same time, it can be said that the proposal has had a mixed reception and the bulk of the opinion appears to be that the scheme is impracticable. It is very much questioned whether the stimulus to trade and the revenue forthcoming would compensate for the cost of the scheme and its administration. What this cost would mean altogether can only be conjectured, but it is estimated that as the total home consumption of coals last year was over 185,000,000 tons, the application of the 2s. 6d. bonus would mean a charge on the National Exchequer of over £23,000,000. Apart from the cost, however, and the problematical benefit to be derived, such a proposal would, of course, mean a measure of Government control, which no one desires in view of past experience. In addition, outside the question of whether other industries should not receive some form of subsidy to help them to meet foreign competition, such as ship repairing, there is the fact that such a scheme does not go to the root of the evil so far as the coal trade is concerned, and that it does not assist in the slightest degree to reduce the costs of production. This ground forms the chief objection of most people to the suggestion.

Miners' Wages.

There will be no change in the wages of colliery workers for the current month. According to the joint accountants' report based on the trading results for the three months ended December last, the wage rate certified is 19.31 per cent. on the 1915 standard, which compares with 18.78 per cent. for the previous month. The minimum under the national agreement is, however, 42.22 per cent., so that the minimum will continue to operate. The ascertainment shows a loss for the month of December of £121,129, which works out at 8.04d. per ton. The average wage during the month was 10s. 10.5d., while the average output per man per shift was 16.38 cwt.

Current Business.

The tone of the coal market has been generally quiet, and so far as large qualities are concerned there has certainly been no improvement, while a good deal of unevenness has been in evidence, as is natural when collieries have been pressed for spot shipment and in need of empty wagons to keep work going at the pits. The restriction in working at the collieries has kept down the supply of small coals, and the result is that these coals have ruled very steady. Some collieries have been asking rather higher prices for smalls by themselves, though they have been disposed to accept a more reasonable figure if the buyer is prepared to take a proportion of large coals at the same time. Anthracite coals have been on the quiet side, though fairly steady. Some of the sized qualities such as beans and nuts have been somewhat scarce.

CONTRACTS.

JOHN THOMPSON WATER TUBE BOILERS, Limited, Imperia House, Kingsway, has received a repeat order from the Falkirk electricity works for one of its vertical straight-tube water-tube boilers, having 5000 square feet of heating surface and suitable for 200 lb. working pressure.

THE WESTINGHOUSE BRAKE AND SAXBY SIGNAL COMPANY, Limited, has received an order for the supply and installation of a large electro-pneumatic signalling plant for Temperley Junction, on the Buenos Aires Great Southern Railway, complete with track circuits and several miles of semi-automatic signalling. The contract is in connection with the quadrupling of the line as far as Temperley, and is in addition to the contract for the equipment of the terminal station at Plaza Constitucion, Buenos Aires, with electro-pneumatic power signalling, &c., already awarded to the company.

THE VICKERS-SPEARING BOILER COMPANY, Limited, Bank Buildings, 20, Kingsway, London, W.C. 2, has recently been successful in securing, in face of keen British and foreign competition, a contract from the municipality of Bloemfontein Electric Supply Department, South Africa, for the complete boiler-house equipment of its new generating station. The equipment comprises four Vickers-Spearing cross-type steel-cased, two-drum water-tube boilers, each having a maximum evaporation of 37,000 lb. per hour at a working pressure of 265 lb. to the square inch, with superheaters to give a final steam temperature of 600 deg. Fah., a horizontal tube economiser to be superimposed on each boiler.

FIRE-FIGHTING APPLIANCES IN JAPAN.—His Majesty's Consu at Osaka (Mr. W. B. Cunningham) reports that he is informed that there is a growing demand in Japan, especially in the country districts, for light motor fire-engines. United Kingdom firms in a position to supply British materials can obtain further particulars on application to the Department of Overseas Trade, 35, Old Queen-street, London, S.W. 1, quoting reference AX. 1681.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	17/6 to 24/–
(1) Spanish	23/–
(1) N. African	23/–
N.E. COAST—	
Native	—
Foreign (c.i.f.)	22/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	4 15 0	—
No. 1 Foundry	4 12 6	—
No. 3 Foundry	4 10 0	—
N.E. COAST—		
Hematite Mixed Nos.	4 6 6	4 6 6
No. 1	4 7 0	4 7 0
Cleveland—		
No. 1	4 4 0	4 4 0
Silicious Iron	4 4 0	4 4 0
No. 3 G.M.B.	3 19 0	3 19 0
No. 4 Foundry	3 18 0	3 18 0
No. 4 Forge	17 0	3 17 0
Mottled	—	—
White	—	—
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
,, ,, Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 15 6	—
,, Forge	3 10 6	—
(3) Derbyshire—		
No. 3 Foundry	4 1 0 to 4 2 0	
Forge	3 16 6	—
(3) Lincolnshire—		
No. 3 Foundry	4 2 6	—
No. 4 Forge	3 17 6	—
Basic	4 0 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	5 2 6 (a) / 5 7 6 (b)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	12 0 0	—
Best ,,	—	—
N.E. COAST—		
Common Bars	12 0 0	—
LANCS.—		
Crown Bars	13 0 0	—
Second Quality Bars	12 0 0	—
Hoops	15 0 0	14 15 0
S. YORKS.—		
Crown Bars	13 0 0	—
Best ,,	13 10 0	—
Hoops	14 10 0	—
MIDLANDS—		
Crown Bars	12 15 0	—
Marked Bars (Staffs.)	15 0 0	—
Nut and Bolt Bars	11 15 0	—
Gas Tube Strip	13 0 0 to 13 2 6	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	13 0 0	—
Ship Plates, ½in. and up	9 15 0	—
Sections	9 10 0	—
Steel Sheets, 3/16in. to ½in.	12 0 0	—
Sheets (Gal. Cor. 24 B.G.)	—	18 10 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	9 5 0	—
Angles	9 0 0	—
Boiler Plates	13 0 0	—
Joists	9 5 0	—
Heavy Rails	9 10 0	—
Fish-plates	13 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	9 10 0	—
Soft Billets	8 10 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	9 0 0†	—
Light ,,	9 5 0 to 9 10 0	
Billets	8 0 0 to 11 0 0†	
MANCHESTER—		
Bars (Round)	10 0 0 to 10 5 0	
,, (others)	9 15 0	—
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	13 15 0	13 10 0
Plates	9 15 0	—
,, (Lancs. Boiler)	13 0 0	—
SHEFFIELD—		
Siemens Acid Billets	11 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	9 10 0	—
Intermediate Basic	9 0 0	—
Soft Basic	8 0 0 to 8 5 0	
Hoops	12 0 0	—
Soft Wire Rods	11 0 0 to 11 10 0	
MIDLANDS—		
Small Rolled Bars	9 0 0 to 9 15 0	
Billets and Sheet-bars	7 0 0 to 7 10 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	17 2 6 to 17 5 0	—
Angles	9 5 0	—
Joists	9 5 0	—
Tees	10 5 0	—
Bridge and Tank Plates	9 15 0	—
Boiler Plates	13 10 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	23/6 to 23/7½
Block Tin (cash)	260 0 0
,, (three months)	262 17 6
Copper (cash)	63 12 6
,, (three months)	64 12 6
Spanish Lead (cash)	37 2 6
,, (three months)	35 10 0
Spelter (cash)	35 7 6
,, (three months)	35 0 0
MANCHESTER—	
Copper, Best Selected Ingots	69 0 0
,, Electrolytic	70 0 0
,, Strong Sheets	95 0 0
,, Tubes (Basis Price)	0 1 1½
Brass Tubes (Basis price)	0 1 0½
,, Condenser	0 1 2½
Lead, English	39 10 0
,, Foreign	38 0 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/8½ per lb.	
Ferro Tungsten	1/4½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 0 0	8/–
,, 6 p.c. to 8 p.c. ,,	£23 10 0	7/9
,, 8 p.c. to 10 p.c. ,,	£23 0 0	7/6
,, Specially Refined		
,, Max. 2 p.c. carbon	£43 0 0	16/–
,, ,, 1 p.c. ,,	£52 0 0	17/6
,, ,, 0.75 p.c. carbon	£58 0 0	20/–
,, ,, carbon free	1/5 per lb.	
Metallic Chromium	4/– per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
,, Silicon, 45 p.c. to 50 p.c.	£12 0 0	scale 5/– per unit
,, ,, 75 p.c.	£19 10 0	scale 6/– per unit
,, Vanadium	17/– per lb.	
,, Molybdenum	7/6 per lb.	
,, Titanium (carbon free)	1/– per lb.	
Nickel (per ton)	£175	
Cobalt	10/– per lb.	
Aluminium (per ton)	£130	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	16/9
,, ,, Ell	18/3
,, ,, Splint	19/– to 23/–
,, ,, Trebles	18/–
,, ,, Doubles	17/–
,, ,, Singles	13/9
AYRSHIRE—	
(f.o.b. Ports)—Steam	16/9
,, ,, Splints	19/–
,, ,, Trebles	18/–
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	15/– to 17/–
Screened Navigation	24/–
Trebles	18/–
Doubles	16/–
Singles	14/–
LOTHIANS—	
(f.o.b. Leith)—Best Steam	16/9
Secondary Steam	15/9
Trebles	19/–
Doubles	17/3
Singles	14/–

ENGLAND.

	Export.
(8) N.W. COAST—	
Steams	28/6
Household	45/– to 58/4
Coke	30/–
NORTHUMBERLAND—	
Best Steams	18/4½ to 18/6
Second Steams	17/6
Steam Smalls	10/3 to 10/6
Unscreened	15/6 to 16/6
Household	23/6 to 25/–
DURHAM—	
Best Gas	21/– to 21/6
Second	18/– to 18/6
Household	23/6 to 25/–
Foundry Coke	23/– to 23/6
SHEFFIELD—	Inland.
Best Hand-picked Branch	30/– to 33/– —
Barnsley Best Silkstone	26/– to 28/– —
Derbyshire Best Brights	26/– to 31/– —
,, ,, House	24/– to 26/– —
,, ,, Large Nuts	22/6 to 25/– —
,, ,, Small	14/– to 16/– —
Yorkshire Hards	19/6 to 23/– —
Derbyshire ,,	19/6 to 22/– —
Rough Slacks	9/6 to 12/– —
Nutty ,,	8/6 to 10/6 —
Smalls	4/– to 6/6 —
Blast-furnace Coke (Inland)*	— —
,, ,, (Export)	f.o.b. 21/6 to 22 –

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	26/9 to 27 –
Second ,, ,,	26/– to 26/6
Best Dry Large	25/6 to 26/6
Ordinary Dry Large	24/– to 24/6
Best Black Vein Large	24/6 to 25/–
Western Valley ,,	23/6 to 24/6
Best Eastern Valley Large	23/6 to 24/6
Ordinary ,, ,,	22/6 to 23/–
Best Steam Smalls	16/– to 16/6
Ordinary ,,	13/– to 15/–
Washed Nuts	22/– to 32/–
No. 3 Rhondda Large	27/– to 27/6
,, ,, Smalls	19/– to 20/–
No. 2 ,, Large	22/6 to 23/6
,, ,, Through	18/– to 20/–
,, ,, Smalls	11/– to 13 –
Foundry Coke (export)	40/– to 47/6
Furnace Coke (export)	25/– to 30/–
Patent Fuel	25/– to 27/–
Pitwood (ex ship)	23/6 to 24/–
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	45/– to 47/6
Seconds	36/6 to 37/6
Red Vein	32/6 to 35/–
Machine-made Cobbles	50/– to 55/–
Nuts	55/– to 57/6
Beans	44/– to 45/–
Peas	20/– to 23/6
Breaker Duff	9/– to 9/6
Rubbly Culm	10/– to 10/6
Steam Coals:	
Large	24/– to 25/6
Seconds	22/6 to 24/6
Smalls	11/6 to 14/–
Cargo Through	17/– to 19/–

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/– extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 16/9, with fluctuations according to analysis; open market, 18/– to 19/– at ovens. † Latest quotations available. (a) Delivered Sheffield or Glasgow. (b) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Business Declension.

AFTER the active production of 1924, when nearly all the statistics showed a considerable progression, there is no doubt that industry is passing through a quiet phase, owing to a feeling of uncertainty arising out of the financial situation. The fear that the heavy burdens imposed from financial necessity will lessen the country's purchasing power and increase production costs still further has caused a suspension of business, which may perhaps be temporary pending a more definite knowledge of what those burdens are likely to be; but while it lasts the situation threatens to be critical for many branches of trade. So far as concerns iron and steel there will certainly be an increased effort to develop the export trade, for while there is at present a tendency towards restricted production the total output is so far in excess of home requirements that the surplus can only be disposed of in foreign markets. Now that Germany is practically closed to Lorraine products they must find an outlet elsewhere. The huge increase in the French production is seen in the returns for last year, showing that the output of coal increased from 38,500,000 tons in 1923 to 45,500,000 tons in 1924, while the production of pig iron was 7,700,000 tons, an augmentation over the previous year of 2,250,000 tons, and steel advanced from 5,100,000 tons to nearly 7,000,000 tons.

German Rolling Stock.

Wagon builders have been seriously concerned by statements to the effect that Government has decided to order 4000 trucks from Germany on account of reparations. Seeing that until recently the shops had been almost entirely destitute of work the placing of such an order was naturally regarded as contrary to the interests of the home industry. It appears, however, that the trucks form part of the material which Germany was to deliver under the Wiesbaden arrangement. The succeeding Governments did not press for delivery, but it is now felt, in the present state of finances which precludes the purchasing of large quantities of rolling stock at home, that Germany should be required to hand over the 4000 trucks without further delay. A considerable amount of other rolling stock is due for reparations, but the Government intends to spread it over a number of years and to distribute orders as far as possible amongst home builders.

Synthetic Fuels.

The Comité Scientifique du Pétrole is carrying out a very exhaustive inquiry into the work accomplished by the laboratories and other research bodies in the synthetic production of fuels. Very satisfactory results are reported to have been obtained by the laboratory instituted by the oil interests, with the participation of the State, as well as by the Service des Poudres, which has of late years given much attention to methods of producing alcohol synthetically. The committee has also received an encouraging report from Professor Mailhe, of Toulouse, who claims that sufficient progress has been made with the economical treatment of vegetable oils with catalysers to warrant the belief that the production of fuels from vegetable oils on an industrial scale in certain African colonies is on the verge of realisation. At the same time a communication has been made to the Société de Chimie Industrielle on the results obtained with the synthetic production of alcohol by the Société Nationale des Recherches sur le Traitement des Combustibles which, by means of a new catalyser, has secured pure methanol from a mixture of carbonic oxide and hydrogen at a temperature of 275 deg. Cent. and under pressures of between 100 and 200 atmospheres. It is claimed that motor spirit can now be obtained on an industrial scale from coal and other solid fuels.

A Super Locomotive.

Last week the Compagnie de l'Est had on view at the Paris terminus what is called the super locomotive which recently left the Epernay shops for preliminary trials. This 4–8–2 locomotive is regarded as the most powerful yet built. It is intended to run between Paris and Strasburg and will haul heavier trains than are customary for express service. It is believed that the loads will be increased by 20 to 25 per cent. on lines with average gradients, and from 30 to 35 per cent. on heavy gradients. The eight driving wheels have a diameter of 1.95 m. The engine was shown alongside a Crampton machine of 1852, which has two driving wheels of 2.3 m. in diameter, and locomotives of the 2400 type of 1898, the 3100 type of 1912, and the Pacific type of 1919.

Colonial Cotton.

In view of the urgency of procuring as much cotton as possible from the colonies, efforts are being made to establish a definite cotton growing policy by legislation so as to provide the Association Cotonnière Coloniale with the funds necessary to carry out its development work. For more than twenty years the Association has been pursuing this work with very modest resources, and it was only recently that it was able to obtain practical results with the aid of voluntary contributions from cotton spinners. While it will probably take very many years to realise the vast project for irrigating cotton-growing territories in West Africa something has already been done in the way of organising and encouraging native cultivation, for which purpose fifteen cotton ginning plants are to be installed this year in different centres. Organised efforts are also being made in Madagascar to develop the native production, and it is hoped that Morocco will also eventually become a source of supply. In order to carry out this work it is proposed to convert the voluntary contributions of spinners to the funds of the Association into a compulsory tax.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

226,613. September 25th, 1923.—WORKING FLUID FOR INTERNAL COMBUSTION MACHINES, M. Benson, 24, St. James's-street, London, S.W. 1.

This invention relates to a system of electrolysing compounds at or above the critical temperature and pressure for the production of an operating fluid for prime movers in which the operating fluid is employed expansively. In contradistinction to the regular method of producing a pressure fluid in internal combustion engines and internal combustion turbines, the inventor proposes a process for producing an expansive working fluid which can be condensed over again and operated continuously in a closed cycle. This working fluid is preferably water or steam, which has been partially or completely dissociated by any suitable means into an explosive mixture. It may be employed under any suitable temperature and pressure conditions, the process, however, being characterised by the fuel—hydrogen—and the combustion supporter—oxygen—being present in theoretical proportions in relation one to the other, there being a sufficient amount of steam, or water vapour, left undecomposed, and therefore present under partial pressure conditions, to regulate the temperature and pressure at which ignition takes place, the velocity of flame propagation, and the temperature and pressure drop of the expanding and condensable working fluid. In carrying out the invention, the inventor takes advantage of the great saving in electric current which he has calculated must be possible when water or steam is electrolysed at or above the critical temperature, and at or above the critical pressure. This saving, he says, must "correspond by comparison with electrolysis at ordinary temperature and pressure, to the difference, expressed in terms of the electrical equivalent of heat, between the latent heat of steam at ordinary atmospheric pressure and at the critical pressure, in addition to which there should be further savings due to the greater closeness of the electrodes, &c., and to the special conditions under which electrolysis is effected. If it were possible to electrolyse water into its constituent parts without any losses whatever, and then to use the constituents so recovered in an internal combustion engine for the production of power, the input and the output of energy would have to be exactly the same. It therefore follows that if we have added, say, two-thirds of the total energy contained in an oxygen-hydrogen mixture from water at a sufficiently high temperature and pressure—above the critical point—then it can take only one-third of the electricity which would be normally required to dissociate it and raise the mixture to the same temperature and pressure, it being assumed that the volumetric conditions in both cases are the same. It must be remembered that if the dissociation and afterwards combustion takes place at or above the critical temperature and pressure, then all the heat resides primarily in the product as sensible heat. One of the objects which this invention seeks to and does accomplish is to prevent the losses due to the use of insufficient and excess air in ordinary internal combustion engines by not using any air at all, and never having any more or less than the theoretically required oxygen present, thus always automatically obtaining the maximum possible temperature drop."—*December 20th*, 1924.

DYNAMOS AND MOTORS.

226,329. November 2nd, 1923.—IMPROVEMENTS IN INDUCTION MOTORS, William Alan Benger and F. and A. Parkinson, Limited, both of Wells Works, Guiseley, Leeds.

This invention has for its object to provide a motor which shall have good starting characteristics, the rotor preferably having a high resistance when starting and a low resistance when running. In a single-phase induction motor, constructed according to this invention, the stator is wound so that, at starting, the field produced has a larger number of poles than has the field employed in the subsequent operation of the motor. The change in the number of poles employed is effected by any suitable switching gear which, in one position, connects the windings in a manner to produce the predetermined number of poles for starting, and, in a second position, alters the connections of the windings so that the smaller number of poles to be used

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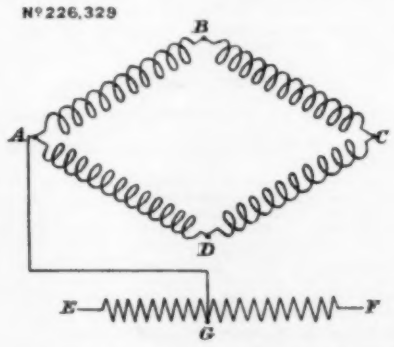

in running is produced. The stator winding is divided into four sections A B C D, the sections C D, D A being so arranged that when the current flows from A to B and A to D the sections A B, A D together give a field of the desired larger number of poles for starting. Similarly, the sections B C and D C are arranged to give the same larger number of poles when the current flows from B to C and D to C, but these windings are displaced angularly from the first two sections. A phase difference is produced in any convenient manner between these two circuits as by the resistance G F, so that for starting the lines are connected to the points E and C respectively and the point F is connected to B and D. The various sections of the windings are such that when the lines are connected to points B and D respectively they combine to give a resultant field with a smaller number of poles for normal running and the resistance E G F is removed from circuit. There are two other diagrams.—*December 24th*, 1924.

226,646. November 2nd, 1923.—IMPROVEMENTS RELATING TO VENTILATION AND COOLING OF ELECTRICAL OR OTHER MACHINES OR APPARATUS, John William Young, of 88, Roseneath-road, Urmston, Manchester, and the Metropolitan-Vickers Electrical Company, 4, Central-buildings, Westminster.

The invention relates particularly to that type of ventilating system in which air channels or ducts communicate with the interior of the machine to be ventilated and with the outer atmosphere. The arrangement for hermetically sealing the air inlet and outlet openings A and B comprises an oil bath or channel C, which is placed in the foundations, and surrounding the air inlet and outlet openings A and B and a projecting flange D on each inlet and outlet damper E and F, which when closed are immersed in oil, that is supplied through a pipe K from a tank L, which is divided into two compartments. The com-

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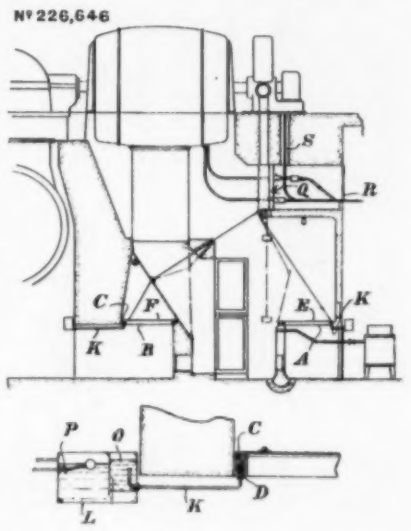

partment O is partially filled with oil, the level of which is maintained by a ball valve P. For sealing the electrical connections to the machine, where they enter the conduit system, an air-tight screen Q may be placed across the back of a special joint box cubicle R, whilst the exciter connections S may be taken direct into the joint box cubicle, which is in communication with the atmosphere, and sealing is therefore unnecessary. The specification is rather a lengthy one, but the foregoing will give a clue to the inventor's idea.—*January 1st*, 1925.

TELEGRAPHS AND TELEPHONES.

226,417. April 4th, 1924.—IMPROVEMENTS IN OR RELATING TO THERMIONIC VALVE CIRCUITS FOR WIRELESS SYSTEMS, Keith Dudley Rogers and George Victor Dowling, both of the Fleetway House, Farringdon-street, London, E.C. 4.

This invention enables large variations of anode current to be obtained, so that in the case of a receiving apparatus sufficiently loud signals are received without the use of a high-tension battery in the anode circuit of a detecting or amplifying valve, irrespective of whether the latter is used for radio or audio frequency amplification. In the case of the scheme shown the aerial tuning coil A or other aerial tuning arrangement is connected in the usual manner through a condenser B to the main grid of the valve. This condenser may be shunted by a high-resistance leak, or a high-resistance leak may be connected between the grid C and the negative end of the filament in a

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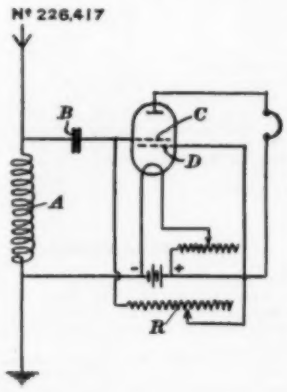


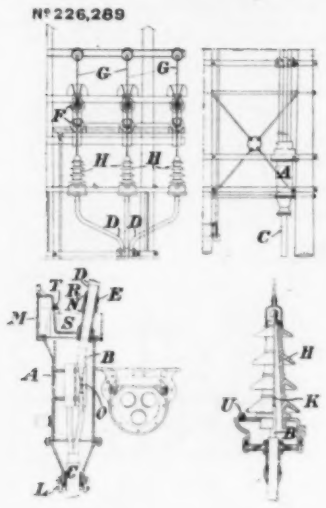
well-known manner. The filament battery has its negative terminal connected to one end of the filament and to the earthed end of the aerial tuning coil, while its positive terminal is connected to the other end of the filament through a rheostat, all in the usual manner. According to the invention, however, the telephones are connected directly between the positive terminal of the low-tension battery and the plate of the valve, and between the main grid C and the filament an additional grid D is provided, which is connected to the positive pole of the filament battery. In addition, the main grid C is also connected to the positive pole of the battery through a high resistance R, which is preferably adjustable, so that the potential bias of the main grid can be adjusted to give the best results. This resistance may be of the order of one-quarter to five million ohms. Three other schemes are also described.—*December 24th*, 7924.

TRANSMISSION OF POWER.

226,289. September 21st, 1923.—IMPROVEMENTS IN DIVIDING BOXES FOR ELECTRIC CABLES, William Collier Beacon, of 10, Charles-street, Kilmarnock, Ayrshire; and Walter Ernest Upton, of Bridge House, Campbell-street, Kilmarnock, Ayrshire.

This invention has particular reference to systems of connecting underground cables with overhead lines, which involve the use of a dividing box between the top of the pole and the ground level. The box A in the accompanying drawings serves as a water-tight sealed envelope, and within it the multicore cable is broken into single cables B. The multicore cable C enters at the base of the box and the corresponding number of single cables emerge from the upper sealed side of the box. These cables are accommodated in lead sheathing D and are led upwards into porcelain sealing bells H near the top of the pole adjacent to the insulators F carrying the overhead wires G. Arranged in each sealing bell H is a junction K connecting the

multiple strand cable C with the overhead wire G. A gland is provided at L to receive the cable C and at the top of the box there is a lid M, which is detachable. The junctions O between the elements of the cable C and the single strands are arranged

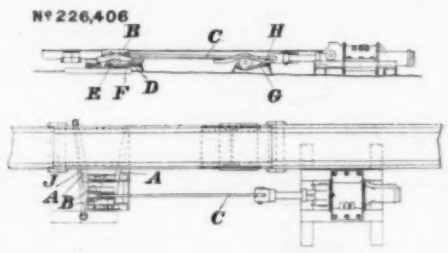


within the box. Ferrules N are provided for the cable B, the lead sheaths being situated at R, whilst the space S is filled with compound through the apertures T. Compound is also poured in at U.—*December 26th*, 1924.

CRANES AND CONVEYORS.

226,406. March 6th, 1924.—DRIVING JIGGING CONVEYORS, H. C. Jenkins, Meco Works, Moorfields, Sheffield; and T. G. Nyborg, 164, Wadsley-lane, Hillaborough, Sheffield.

This method of driving a jigging conveyor from the side is said to reduce sideways oscillations to a minimum. A pair of lateral projecting angle irons A A form a frame or bracket, at the outer end of which is attached the connection B for the engine connecting-rod C. Preferably several holes are formed in this connection, to any one of which the end of the connecting-rod may be pivoted so as to give longitudinal adjustment. Underneath this connection is attached a top roller path D

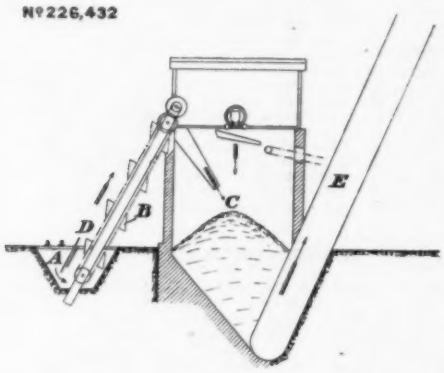


supported by a roller E running in a fixed roller frame F. The roller path and frame are so formed that the connecting piece is constrained to move in a path parallel with that of the troughs, set by the normal roller paths such as those shown at G and H. In order to control the lateral vibration in the trough there is a cross lever J, of which one end is pivoted to the far side of the trough and the other end to a fixed anchorage at some distance from the trough, so that lateral movement of the trough is controlled while allowance is made for the slight amount of necessary vertical movement at the pivot points.—*December 24th*, 1924.

MISCELLANEOUS.

226,432. May 20th, 1924.—IMPROVEMENTS IN AND RELATING TO THE MANUFACTURE OF COKE, Berg und Huttenwerks Gesellschaft, of Reitschulgasse 5, Brunn, Czecho-Slovakia; and Alfred Gobiet, of Hoheneggerschacht, Karwin, Czecho-Slovakia.

This specification describes an improved process for the manufacture of coke, which is to be used in blast-furnaces. The impoverishing material—for example, coke slack—is mixed dry in fixed proportions with the coal. The coke slack is brought



in tip wagons or other transporting means to the elevator pit A and from there is conveyed by means of the elevator B to the large-coal bunker C, whence the mixed materials are brought by the elevator E to the coal washing or dressing machines or jigs. The regulation of the proportion of impoverishing material to the raw coal is effected in this arrangement either by varying the speed at which the elevator B works or by regulating the quantity of the impoverishing material fed to the elevator B by means of a slide D. The whole process, the inventors explain, works extremely economically, for a coke of great strength is produced, loss of material does not occur, and the expenditure of power and wear of machinery is extremely low.—*December 24th*, 1924.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTION OF AERONAUTICAL ENGINEERS.—The Engineers' Club, Coventry-street, London, W. 1. Paper, "Flying in Australia," by Mr. H. L. J. Hinkler. 6.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, Westminster, London, S.W. 1. "Anti-friction Bearing Applications for Heavy Duty," by Mr. J. B. Dahlerus. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Lecturette, "The Measurement of Hardness and Allied Properties of Metals," by Mr. E. G. Herbert. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "The Earliest Recorded Kings of the English," by Professor R. W. Chambers. 9 p.m.

SATURDAY, FEBRUARY 7TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—Grand Hotel, Aytoun-street, Manchester. Lecture, "A Psychological Examination of Foundry Life," by Mr. V. C. Faulkner. 4 p.m. To be followed by annual dinner at 6.30 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS: MIDLAND COUNTIES BRANCH.—Medical Lecture Theatre, The University, Edmund-street, Birmingham. Paper, "The Design and Construction of Steel-frame Buildings," by Mr. V. H. Lawton. 7.15 p.m.

MONDAY, FEBRUARY 9TH.

INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Paper, "Methods of Keeping Foundry Records," by Mr. J. A. Gardner. 7.30 p.m.

NORTHAMPTON ENGINEERING COLLEGE ENGINEERING SOCIETY.—St. John-street, London, E.C. 1. "Ball Bearings," by Mr. F. O. Moysey. 5.30 p.m.

SURVEYORS' INSTITUTION.—12, Great George-street, London, S.W. 1. Papers, "Current Compensation Problems in Connection with (*a*) Tube Railways," by Mr. F. W. Hunt; (*b*) "Arterial Roads," by Mr. S. A. Smith; and (*c*) "Land Returned by Government Departments," by Mr. C. G. Eve. 8 p.m.

TUESDAY, FEBRUARY 10TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH, BURNLEY SECTION.—Municipal College, Ormerod-road, Burnley. Paper, "Machine Tool Work," by Mr. H. Jowett. 7.15 p.m.

INSTITUTE OF MARINE ENGINEERS.—85-88, The Minories, Tower-hill, London, E. 1. President's address. 6.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "Some Notes on British Methods of Continuous Production," by Mr. F. G. Woollard. 7 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Broadgate Café, Coventry. Coventry Graduates' meeting. Paper, "Aluminium, its Alloys and their Use in the Automobile Industry," by Mr. G. H. Day. 7.15 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, London, S.W. 1. Paper, "Considerations in the Development of Water Power, with Special Reference to India," by Mr. B. D. Richards. 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH MIDLAND CENTRE.—Hotel Metropole, King-street, Leeds. Informal discussion on "Domestic Electrical Apparatus." 7 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—207, Bath-street, Glasgow. Paper, "Three-wire Direct-current Distribution Networks. Some Comparisons in Cost and Operation," by Mr. H. W. Taylor. 7.30 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS.—Midland Hotel, Manchester. Anniversary dinner. 6.15 for 6.45 p.m.

WEDNESDAY, FEBRUARY 11TH.

INSTITUTION OF AUTOMOBILE ENGINEERS: WOLVERHAMPTON CENTRE.—The Engineers' Club, Wolverhampton. Paper, "Some Notes on British Methods of Continuous Production," by Mr. F. G. Woollard. 7.30 p.m.

INSTITUTION OF CHEMICAL ENGINEERS.—Institution of Mechanical Engineers, Storey's-gate, London, S.W. 1. Joint meeting with Chemical Engineering Group. Papers: "Internal Combustion Boilers," by Mr. Oscar Brunler; and "Steam Generation under Critical Conditions," by Mr. D. Brownlie. 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, London, S.W. 1. Informal meeting. Discussion on "The Transport Lay-out of a Large Factory," introduced by Mr. F. Turner. 7 p.m.

INSTITUTION OF ENGINEERS-IN-CHARGE.—St. Bride Institute, Bride-lane, London, E.C. 4. Paper, "Commercial Road Transport," by Mr. G. T. Sharpe. 7.30 p.m.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—Old Colony Club, Aldwych, London, W.C. 2. Annual general meeting. Paper, "Unsettled Questions in Heating and Ventilation," by Mr. A. H. Barker. 2.30 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "The Diesel Engine in Navigation," by Sir J. Fortescue Flannery. 4.30 p.m.

THURSDAY, FEBRUARY 12TH.

ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN: BIRMINGHAM AREA.—Chamber of Commerce, New-street, Birmingham. Lecture, "Boiler House Lay-out and Management," by Mr. P. S. Woolley. 7.30 p.m.

INSTITUTE OF METALS: LONDON LOCAL SECTION.—Institute of Marine Engineers, 85-88, The Minories, London, E. 1. Paper, "Some Notes on Refractory Materials," by Mr. V. C. Faulkner. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "The Properties and Structure of Quartz—III.," by Sir William Bragg. 5.15 p.m.

FRIDAY, FEBRUARY 13TH.

DIESEL ENGINE USERS' ASSOCIATION.—The Engineers' Club, Coventry-street, London, W. 1. Paper, "Submarine Engines and High-speed Heavy-Oil Engine Electric Generating Sets," by Mr. P. A. Holliday. 3.30 p.m.

INSTITUTE OF MARINE ENGINEERS.—Hotel Victoria, London, W.C. 2. Annual conversazione. 6.30 p.m.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—198, West-street, Sheffield. Joint meeting with the Sheffield Metallurgical Association. Paper, "Fuel and its Efficient Utilisation," by Dr. C. H. Lander. 7.30 p.m.

INSTITUTE OF METALS: SWANSEA LOCAL SECTION.—Metallurgical Department, University College, Singleton Park, Swansea. Paper, "Season Cracking and its Prevention," by Dr. H. Moore. 7.15 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, London, S.W. 1. Informal meeting. Discussion on "Gear Production Machinery." 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS: YORKSHIRE BRANCH.—Philosophical Hall, Leeds. Paper, "Anti-friction Bearing Applications for Heavy Duties," by Mr. J. B. Dahlerus. 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Honorary members' lecture, "Milestones in the Development of the Prime Mover Locomotive," by Mr. Loughnan Pendred. 7.30 p.m.

PHYSICAL SOCIETY OF LONDON.—Imperial College of Science and Technology, South Kensington, London, S.W. 7. Annual general meeting. Address on "A System of Electrical Measurements," by Mr. F. E. Smith. 5 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "The Forces of Law and Order in a Primitive Community," by Dr. Malinowski. 9 p.m.

SATURDAY, FEBRUARY 14TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH, JUNIOR SECTION.—College of Technology, Sackville-street, Manchester. Lecture, "Some Foundry Experiences," by Mr. W. H. Meadowcroft. 7 p.m.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—Queen's Hotel, Birmingham. Annual dinner.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Florence Restaurant, Rupert-street, London, W. 1. London Graduates' annual dinner. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—The College, Loughborough. Loughborough Graduates' meeting. 7.30 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS: WESTERN COUNTIES BRANCH.—Royal Institution, Swansea. Paper, "Piles and Pile Foundations," by Mr. G. B. R. Pimm. 6 p.m.

MONDAY, FEBRUARY 16TH.

INSTITUTION OF AUTOMOBILE ENGINEERS: BIRMINGHAM CENTRE.—Chamber of Commerce, New-street, Birmingham. Paper, "Some Notes on British Methods of Continuous Production," by Mr. F. G. Woollard. 7 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: SCOTTISH CENTRE.—Royal Technical College, Glasgow. Paper, "Marine Motor Installation," by Mr. C. H. Macmillan. 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS: NORTH-WESTERN SECTION.—Geographical Society's Rooms, 16, St. Mary's Parsonage, Manchester. Lecture, "The Design and Construction of the No. 5 Gas Holder for Burnley Corporation," by Mr. A. D. Young. 7.15 p.m.

TUESDAY, FEBRUARY 17TH.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—Freemasons' Hall, 96-98, George-street, Edinburgh. Faraday Lecture, "World-wide Radio Telegraphy," by Professor G. W. O. Howe. 7.45 p.m.

WEDNESDAY, FEBRUARY 18TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Chamber of Commerce, New-street, Birmingham. Birmingham Graduates' meeting. 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, London, S.W. 1. Students' meeting. Paper, "Reconstruction of Barrow Haven Bridge, Lincolnshire, L. and N.E. Railway," by Mr. R. H. Tangri. 6 p.m.

THURSDAY, FEBRUARY 19TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Cavendish Café, Cornmarket, Derby. Derby Graduates' meeting. Lantern lecture, "The Early History of Road Transport," by Mr. R. Bolton. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Joint meeting with the Royal Aeronautical Society. Lecture, "Light Aeroplane Engine Developments," by Lieut.-Colonel L. F. R. Fell. 7 p.m.

FRIDAY, FEBRUARY 20TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—London Graduates' visit to the Lighting Service Bureau of the Electric Lamp Manufacturers' Association, 15, Savoy-street, London, W.C. 2. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Queen's Hotel, Coventry. Coventry Graduates' fourth annual dinner. 7.30 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—The Engineers' Club, Coventry-street, London, W. 1. Annual dinner. 6.30 for 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Lecturette, "Inverted Tooth Chain Drives," by Mr. J. M. Seddon. 7.30 p.m.

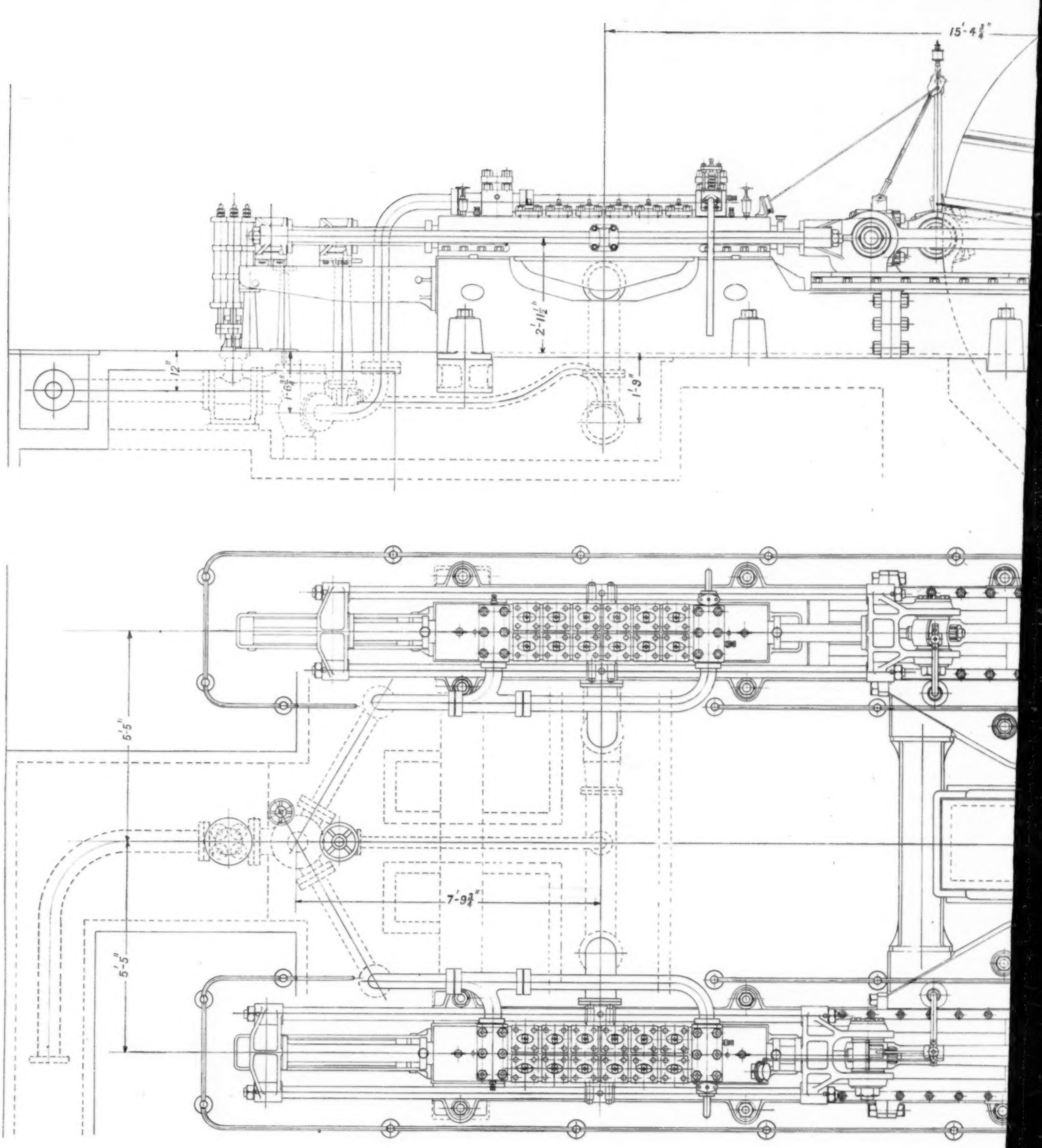
SATURDAY, FEBRUARY 21ST.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—The Grosvenor Restaurant, Gordon-street, Glasgow. Smoking concert. 7 p.m.

THURSDAY, FEBRUARY 26TH.

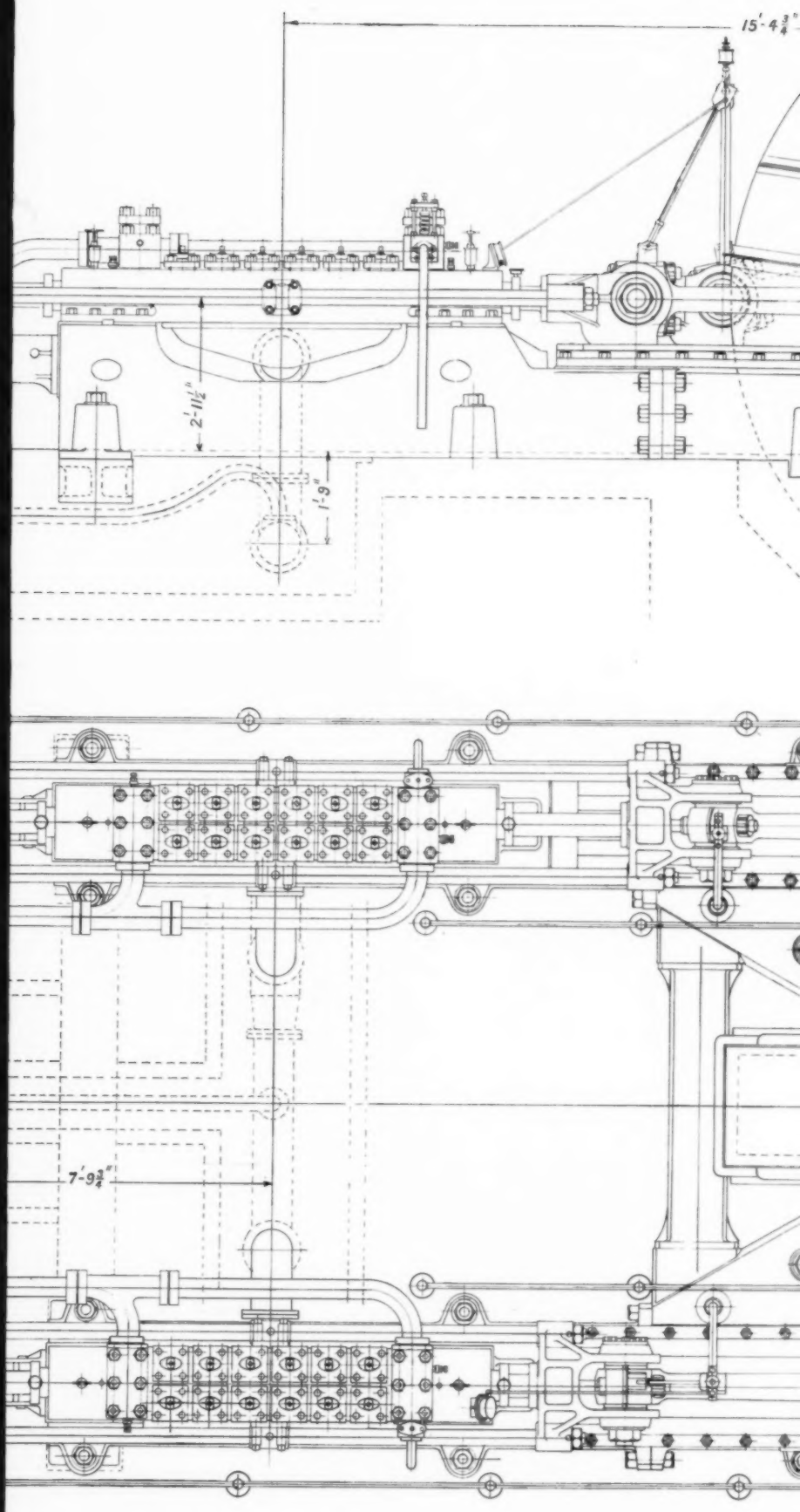
INSTITUTION OF STRUCTURAL ENGINEERS.—Denison House, 296, Vauxhall Bridge-road, London, S.W. 1. Paper, "Reinforced Concrete Columns," by Mr. Edward Godfrey. 8 p.m.

FARADAY HOUSE.—The annual examinations for a Faraday Scholarship of fifty guineas per annum, tenable for two years in college and one year in manufacturing works, and for a Maxwell Scholarship of fifty guineas per annum, tenable for one year in college and one year in works, will be held at Faraday House on April 7th, 8th, and 9th, next. Further particulars may be obtained from the Secretary, Faraday House, 62-70, Southampton-row, London, W.C. 1.



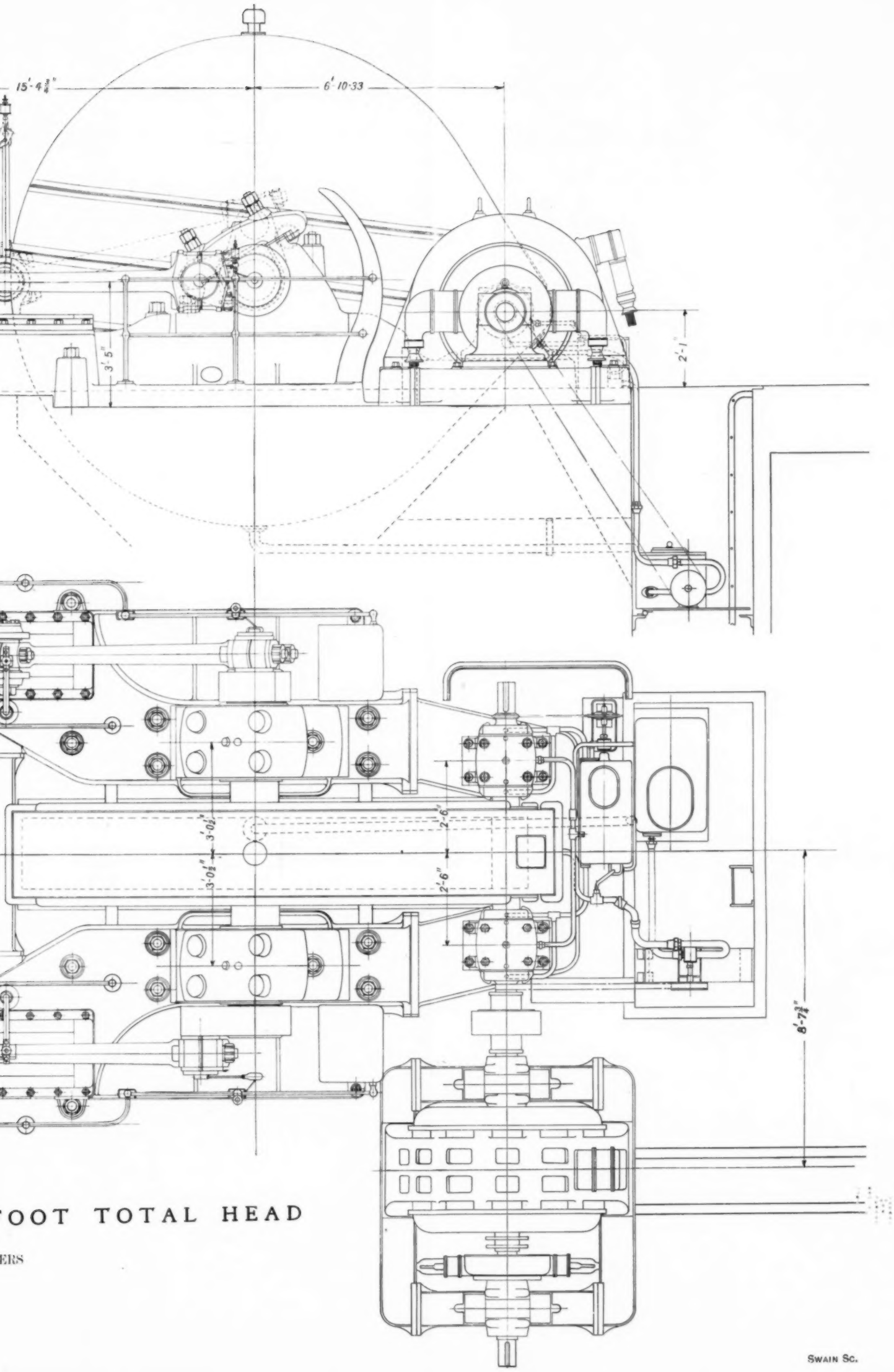
SIMLA WATER SUPPLY—PUMPS FOR 4200 FOOT

HATHORN, DAVEY AND CO., LIMITED, LEEDS, ENGINEERS



ER SUPPLY—PUMPS FOR 4200 FOOT

HATHORN, DAVEY AND CO. LIMITED, LEEDS, ENGINEERS



OOT TOTAL HEAD

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